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EPIDEMIOLOGICAL REPORT NO. 12-MA-09H8-08

# EFFECTIVENESS OF A SEAT PAD IN REDUCING BACK PAIN IN LONG-DISTANCE DRIVERS DEPLOYED TO KUWAIT OCTOBER 2008 – MAY 2009

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**14. ABSTRACT** The Skydex® seat pad was tested to see if it could reduce low back pain (LBP) among drivers performing long-distance driving missions from Kuwait into Iraq. One group of military drivers received the seat pads (SP group), while another did not (NSP group). Questionnaires were administered before the seat pads were issued and about 6 months after the seat pads were issued. Soldiers also completed a survey after each driving mission that asked them to rate their back pain (10-point scale, 1= low pain, 10=extreme pain) before and after their driving missions. The study initially included 53 NSP Soldiers and 45 SP Soldiers, but loss to follow-up resulted in 13 NSP Soldiers and 43 SP Soldiers available for analysis. Questionnaire responses before and after issuing the seat pads indicated that more NSP Soldiers reported LBP in the 6-month period after the seat pads were issued (intervention period) compared with the 6-month period before the seat pads were issued (pre-intervention period). In contrast, more Soldiers in the SP group reported LBP during the pre-intervention period (compared with the NSP group), but during the intervention period, that number declined or remained the same. On the mission surveys, the NSP group doubled their subjective rating of back pain after the missions (2.4±1.7 to 4.9±2.2), while the SP group had identical before and after mission ratings (3.0±2.7 versus 3.0±2.8) (interaction $p<0.01$). SP group members with before-mission back pain ratings >3 were analyzed separately: on SP missions where Soldiers reported using seat pads (47% of missions), there was a decline in after-mission back pain (5.2±1.7 to 4.6±2.0); on missions where Soldiers reported not using the seat pad (53% of missions), there was an increase in after-mission back pain (5.1±1.7 to 5.6±2.2) (interaction $p<0.01$). Although there were severe limitations to this project, data suggest that the Skydex® seat pad may reduce driving-related back pain among drivers who have high levels of pre-driving back pain.

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# EXECUTIVE SUMMARY
# EPIDEMIOLOGICAL REPORT NO. 12-MA-09H8-08
# EFFECTIVENESS OF A SEAT PAD IN REDUCING BACK PAIN
# IN LONG-DISTANCE DRIVERS DEPLOYED TO KUWAIT
# OCTOBER 2008 – MAY2009

1. INTRODUCTION. In 2007, a physical therapist attached to a transportation battalion of the 1st Theater Sustainment Command, Camp Arifjan, Kuwait, reported that 36% of the battalion experienced back pain severe enough to seek medical care. In an effort to reduce back pain, the unit examined several types of seat pads and decided to purchase the Skydex® brand. A request for funding was made to the Defense Safety Oversight Council (DSOC) and funds to purchase about 50 seat pads were approved by the DSOC Deployment and Operations Task Force. Because such seat pads had not been adequately assessed in the field in the past, the Ergonomics and the Injury Prevention Programs of the United States Army Center for Health Promotion and Preventive Medicine recommended that an evaluation of the seat pad be conducted. The transportation unit agreed. The major purpose of this project was to determine the incidence of low back pain (LBP) among drivers who used and did not use the Skydex® seat pad. A secondary purpose was to obtain baseline information on military vehicle driver back pain.

2. METHODS.

a. The Skydex® seat pad consisted of a fabric-covered lumbar support and proprietary cushion composed of plastic ellipses or squares. The lumbar support was 5 cm in thickness. The plastic ellipses or squares were composed of thermoplastic polyurethane. Data from Skydex® impact testing on static military vehicle seats indicated a reduction in impact energy (acceleration) transferred to the top of the seat pad when compared with standard military vehicle seats.

b. The 4th Sustainment Brigade at Camp Arifjan, Kuwait, selected drivers in two companies to participate in the project. Drivers in one company were issued the seat pads (SP group), while drivers in another company were not issued seat pads (NSP group). All selected Soldiers were drivers or passengers, primarily in High Mobility Multipurpose Wheeled Vehicles (HMMWV) providing security for Heavy Equipment Transport Systems during missions from Kuwait into Iraq. Most missions involved multiple days and overnight stops at fixed forward operating bases.

c. The project had two phases, a pre-intervention period and an intervention period. In the pre-intervention period, a background questionnaire was administered to both groups. This survey requested information on low back pain (LBP) in the last 7 days, LBP in the last 6

months, LBP while driving, and other information. Seat pads where then distributed to the SP group. During the intervention period, both SP and NSP group members were asked to fill out mission surveys each time they completed a driving mission. The mission survey asked Soldiers about back pain before and after their driving missions (10 point pain scale, 1=low pain, 10=extreme pain) and other information. About 6 months after the start of the project, the Soldiers completed a final post-project questionnaire. The items on the post-project questionnaire duplicated many of those on the baseline questionnaire, but asked specifically about LBP in the intervention period. The Soldiers were also asked what they liked and disliked with regard to the seat pad. Data on the background questionnaire (pre-intervention period data) were compared with data on the post-project questionnaire (intervention period data). Mission surveys were analyzed separately.

3. RESULTS.

a. Initially, 53 Soldiers in the NSP group and 45 Soldiers in the SP group completed the background questionnaire. However, many of the Soldiers in the NSP group had departed Kuwait before administration the post-project questionnaire. There were 13 NSP Soldiers and 43 SP Soldiers who completed both questionnaires and were thus considered in the final analyses.

b. At the start of the project, the NSP and SP groups had served similar times in Kuwait, 43±44 versus 49±15 days, respectively ($p=0.44$). The time between the background questionnaire and post project questionnaire was 201±3 days for the NSP group and 199±6 days for the SP group ($p=0.23$). The 13 Soldiers in the NSP group were all National Guardsmen, while the 43 Soldiers in the SP group were all active Army.

c. The number of NSP Soldiers reporting LBP in the last 7 days increased from the pre-intervention period to the intervention period (from 58% to 85%); in contrast, more SP Soldiers reported pre-intervention 7-day LBP (compared with the NSP Soldiers), but LBP declined in the intervention period (from 84% to 72%). The proportion of NSP Soldiers reporting LBP in the last 6 months increased from the pre-intervention period to the intervention period (from 67% to 85%); in contrast, the proportion of SP Soldiers experiencing LBP in the last 6 months was the same in the pre-intervention and intervention periods (84%). The proportion of NSP Soldier reporting LBP after driving or riding was higher in the intervention period compared with the pre-intervention period (54% versus 92%); in contrast, the proportion of SP Soldiers reporting back pain after driving or riding was lower in the intervention period compared with the pre-intervention period (86% versus 76%).

d. The post-project questionnaire asked Soldiers what they liked and disliked about the seat pads. Most of the Soldiers' favorable comments fell into a category of general comfort without a specific reason for that comfort, although some Soldiers reported that they favored the seat pad back support. The most specific reason for disliking the seat pad was that it reduced headroom

in the HMMWV the Soldiers drove. Soldiers also reported problems "fitting" on the seat pad, properly adjusting the seat pad, and that it caused the buttocks to sweat too much.

e. After 112 days of the intervention period, no further mission questionnaires were provided by the NSP group. All NSP and SP members providing mission questionnaire in this first 112 day period were considered in the analysis of the mission questionnaires to increase statistical power. The NSP group (n=31) provided 52 mission questionnaires, while the SP group (n=50) provided 242 questionnaires. SP group participants reported using seat pads on 47% of the missions and of those who used the pads, they reported using them 78% of the time on those missions. Combining all mission data showed that the NSP group doubled their subjective rating of back pain after the missions (2.4±1.7 to 4.9±2.2) while the SP group had identical average before- and after-mission ratings (3.0±2.7 versus 3.0±2.8) (interaction $p<0.01$). SP group members with before-mission back pain ratings >3 were analyzed separately: on SP missions where seat pads were used, Soldiers reported an after mission-decline in pain (from 5.2±1.7 to 4.6±2.0); on missions where the seat pad was not used, Soldiers reported an after-mission increase in back pain (from 5.1±1.7 to 5.6±2.2) (interaction $p<0.01$).

f. To determine the prevalence of LBP among vehicle drivers, responses from all Soldiers who completed the background questionnaire were analyzed (n=98). LBP in the last 7 days, last 6 months, and currently while driving was reported in 76%, 80%, and 82% of the entire group.

4. DISCUSSION.

a. On the background and post-project questionnaires, the NSP group had an increase in the proportion of Soldiers reporting back pain in the intervention period compared with the pre-intervention period. In contrast, the SP group had a larger proportion of Soldiers reporting back pain in the pre-intervention period (compared with the NSP group), but in the intervention period, that proportion declined (7 day LBP and LBP while driving) or stayed the same (6 month LBP). On the mission questionnaires, the NSP doubled their subjective rating of back pain after the mission, while the SP group had similar before and after mission ratings. When only SP group members with high (>3) before-mission back pain ratings were considered, on missions were the seat pad was used, SP Soldiers reported an after-mission decline in pain; on missions where the seat pad was not used, SP Soldiers reported an after-mission increase in back pain. Taken together, these data suggest that the seat pad mitigated driving-related back pain among Soldiers who had higher before-mission back pain (i.e., pre-existing back pain).

b. Studies that have asked about driver back pain in the last seven days have found prevalences ranging from 17% to 62% compared with 76% in the present study. No studies were found asking about driver low back problems in the last 6 months; however, studies examining LBP in the last year report prevalences from 27% to 84% compared with the 6-month prevalence of 80% here. Studies on transportation workers experiencing pain while driving report prevalences from 37% to 81% compared with 82% here. These comparisons indicate that the

prevalence of self-reported low back problems was higher among these Army vehicle drivers than among other samples of vehicle drivers.

5. CONCLUSIONS. This project had severe limitations, including (1) loss to follow-up of 75% of the original NSP group and (2) the limited number of mission surveys returned by the NSP group. Nonetheless, the project provided some support for the concept that the Skydex® seat pad may reduce driving-related back pain among drivers who have high pre-driving levels of back pain. The incidence of self-reported back pain in these Soldiers was much higher than reported by civilian drivers. Soldiers identified problems with the seat pad, principally that the seat pad reduced headroom in the HMMWV. Soldiers also complained of seat pad fitting and adjustment problems and that the seat pad caused too much sweat.

6. RECOMMENDATIONS. Seat pads should be further evaluated, especially among long-distance drivers who have high levels of pre-mission back pain. The seat pad should also be further tested in vehicles that provide more headroom and/or redesigned so that Soldier are not elevated in the HMMWV seat. More adequate ways of attaching the pad to the seat and ways of increasing ventilation should be considered.

## CONTENTS

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1. REFERENCES. Appendix A contains the scientific/technical references used in this report.

2. INTRODUCTION. In 2007, a physical therapist attached to a transportation battalion of the 1st Theater Sustainment Command, Camp Arifjan, Kuwait reported that 36% of the battalion experienced back pain severe enough to seek medical care. As a consequence, the unit began looking for commercial off-the-shelf seat pads in the hopes that use of such seat pads in military vehicle might reduce the incidence of back problems in the unit's drivers. The unit tried several types of pads but found most inadequate. One seat pad, Skydex®, seemed to meet the dual needs for back/postural support and vibration attenuation that the unit was seeking. A decision to purchase Skydex® seat pads was made in August 2007 and a request for funding was made to the Defense Safety Oversight Council (DSOC). Funds to purchase about 50 seat pads were procured by the DSOC Deployment and Operations Task Force. Because such seat pads had not been adequately assessed in the field in the past, the USACHPPM Ergonomics Program, supported by the Injury Prevention Program, recommended that an evaluation of the seat pad be conducted and the transportation unit agreed.

3. PURPOSE. The major purpose of this project was to determine the incidence of lower back complaints among drivers who used and did not use seat pads purchased by their transportation units. Additional purposes were to (1) obtain baseline information on vehicle driver back pain and (2) obtain exposure rates (number of hours of driving) for vehicle drivers in the Kuwait/Iraq theaters.

4. AUTHORITY. Under Army Regulation 40-5[1], the US Army Center for Health Promotion and Preventive Medicine (CHPPM) is responsible for providing epidemiological consultation services upon request. This project was requested by the 1st Sustainment Command, Camp Arifjan, Kuwait; the request letter is in Appendix B. Employing the criteria of the Council of the State and Territorial Epidemiologists[2], it was determined that this project constituted public heath practice.

5. BACKGROUND.

a Low Back Injury Rates in Army Motor Vehicle Operators

(1) Data on civilian drivers indicate that they have a higher incidence of low back problems than individuals employed in other occupations[3-6]. To see if this was the case for Army drivers, the Defense Medical Epidemiological Database (DMED) was used to examine back injury rates in motor vehicle operators. Army motor vehicle operators were compared with

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the rest of the US Army, exclusive of motor vehicle operators. The ICD-9 codes selected were those developed by Cherkin et al.[7], with modifications by Krause et al. (8); an additional code for spinal stress fractures was included. These codes involve acute and chronic conditions originating in the lumbosacral spine that are not associated with neoplastic conditions, infections, or pregnancy[7]. Appendix C lists the codes and diagnoses. There are 10 major code groupings, consisting of herniated disc, probable degenerative changes, spinal stenosis, radiating back pain, possible instability, nonspecific backache, sequelae of previous back surgery, fracture, stress fracture, and miscellaneous back problems. An additional category (all low back problems) combines all the codes with the exception of those involving frank fractures.

(2) To determine back injury rates, the ICD-9 codes in these code groupings were selected in the DMED ICD-9 Explorer (http://afhsc.army.mil). The entire Army was selected for cases over 10 years (1998–2007) for all geographic locations. In the first runs, "motor vehicle operators" were selected from the occupational codes. In the subsequent runs, "all occupational groups" were selected. The "motor vehicle operators" cases and denominators were subtracted from the "all occupational groups" cases and denominators.

(3) Table 1 shows the results. Among male and female motor vehicle operators, there were 101,325 and 24,437 person-years of follow-up, respectively. Among male and female Army personnel, exclusive of motor vehicle operators, there were 4,027,795 and 690,119 person-years of follow-up, respectively. Compared with the rest of the US Army, male motor vehicle operators had a 25% higher rate of low back problems and female motor vehicle operators had an 11% higher rate (last row Table 1). This was primarily due to a higher rate of non-specific low back problems. Male motor vehicle drivers also had a higher rate of probable degenerative changes compared with the rest of the men in the US Army. Surprisingly, female drivers had a lower rate of spinal stenosis and spinal stress fractures compared with the rest of the women in the Army.

(4) Although we could not obtain the ages of the motor vehicle drivers in this dataset, it can be assumed that they approximate the average age in the Army, which is about 28 years (estimated from data at http://www.armyg1.army.mil/hr/docs/demographics/FY05%20Army%20Profile. pdf). Because of their presumed young age, Army drivers may not have had sufficient exposure to develop more serious problems like herniated discs and sciatic pain and are only now experiencing nonspecific low back pain (LBP). How this may influence future low back problems is not known.

Table 1. Rates of Low Back Problems of Army Motor Vehicle Operators Compared with the US Army Exclusive of Motor Vehicle Operators

| ICD-9 Code Grouping | Motor Vehicle Operators (cases per 1000 person-years) | | | US Army Except Motor Vehicle Operators (cases per 1000 person-years) | | | Rate Ratio (Motor Vehicle Operators/ US Army Except Motor Vehicle Operators) | | | p-value[a] (Motor Vehicle Operators vs. US Army Except Motor Vehicle Operators) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Men | Women | All | Men | Women | All | Men | Women | All | Men | Women | All |
| Herniated Disc | 28.5 | 23.9 | 27.6 | 27.0 | 23.4 | 26.5 | 1.06 | 1.02 | 1.04 | <0.01 | 0.64 | 0.01 |
| Probable Degenerative Changes | 33.2 | 35.8 | 33.7 | 27.4 | 34.9 | 28.5 | 1.21 | 1.02 | 1.18 | <0.01 | 0.48 | <0.01 |
| Spinal Stenosis | 2.2 | 1.0 | 1.9 | 2.2 | 1.8 | 2.2 | 0.97 | 0.56 | 0.89 | 0.64 | <0.01 | 0.08 |
| Radiating Back Pain | 5.9 | 9.2 | 6.5 | 5.6 | 11.1 | 6.4 | 1.05 | 0.83 | 1.02 | 0.26 | 0.01 | 0.63 |
| Possibility Instability | 4.5 | 7.7 | 5.1 | 4.5 | 8.7 | 5.1 | 1.00 | 0.88 | 1.00 | 0.94 | 0.04 | 0.95 |
| Nonspecific Backache | 388.0 | 590.8 | 427.4 | 295.3 | 505.6 | 326.1 | 1.31 | 1.17 | 1.31 | <0.01 | <0.01 | <0.01 |
| Sequelae, Previous Back Surgery | 1.3 | 1.8 | 1.4 | 1.5 | 1.3 | 1.5 | 0.86 | 1.40 | 0.95 | 0.09 | 0.03 | 0.47 |
| Fracture | 1.7 | 2.5 | 1.8 | 1.8 | 1.7 | 1.8 | 0.94 | 1.50 | 1.04 | 0.42 | <0.01 | 0.57 |
| Stress Fracture | 0.1 | 0.1 | 0.1 | 0.3 | 1.3 | 0.4 | 0.43 | 0.06 | 0.25 | <0.01 | <0.01 | <0.01 |
| Miscellaneous Back Problems | 47.9 | 71.7 | 52.5 | 45.8 | 79.2 | 50.7 | 1.04 | 0.91 | 1.04 | <0.01 | <0.01 | <0.01 |
| All Low Back Problems[b] | 511.5 | 742.0 | 556.2 | 409.6 | 667.3 | 447.3 | 1.25 | 1.11 | 1.24 | <0.01 | <0.01 | <0.01 |

Legend: ICD-9 = International Classification of Diseases, Version 9
Notes:
[a]Chi square for rates[9]
[b]Includes all ICD-9 codes for back pain except those for frank fractures

b. Prevalence and Risk Factors for Low Back Pain in Civilian Drivers

(1) Population surveys of workers in the US and Canada have shown that individual involved in transportation occupations have 1.6 to 2.7 times the prevalence of low back problems compared with population averages[3-6]. Vehicle drivers have been shown to be at high risk for a number of spinal problems, including sciatica, spondyloarthrosis, disc herniation, and generalized LBP[10-24].

(2) Table 2 shows studies that have examined the prevalence of low back problems among vehicle drivers. Comparisons among studies were complicated by differences in the types of drivers examined (e.g., bus, tractor, taxi), different methods of determining prevalence (e.g., interview, questionnaire, workman's compensation claims), and different definitions of low back problems (e.g., any LBP, lumbar disc herniation, spinal injury). Twelve-month prevalence estimates for any LBP ranged from 27% for commercial travelers[25] to 83% for bus drivers[11]. Estimates of 7-day prevalence of low back pain ranged from 17% for tractor drivers[26] to 62% for bus drivers[11]. Studies that compared vehicle drivers to nondrivers[11, 16, 20, 22, 23, 26, 27] showed a

higher incidence of low back problems among drivers regardless of the case definition or survey period (e.g., current back pain to lifetime prevalence of back pain).

(3) Table 2 also shows studies that have examined a variety of risk factors for low back problems among vehicle drivers. Again, comparisons among studies were complicated by the methodological differences noted above, but a few consistent findings did emerge. Lifting at work in association with driving[22, 25, 28] or prior low back problems[26, 28, 29] were associated with current low back problems. More exposure to driving either in terms of times per week, hours per week, or miles driven per week was associated with low back problems in most studies[8, 25-28, 30-33], but not all[13, 29, 34-38]. Awkward postures or bending and twisting while driving was associated with low back problems in most studies[11, 20, 26, 28, 32], but not all[29, 35, 38]. Generally, physical characteristics like height, weight, and body mass index (BMI) have not been shown to be associated with low back problems in drivers[11, 13, 20, 22, 26, 28-30, 33, 36, 38]. Age shows conflicting results[8, 11, 13, 20, 26, 29, 30, 33, 36, 38], but this is likely to be due to selection bias. For example, one study found that sedentary workers had a higher prevalence of chronic back pain with age, while back pain decreased in drivers, suggesting that drivers who developed back pain may have left the profession and taken up more sedentary jobs[39]. Studies on the association between low back problems and gender[8, 13, 25, 26, 29, 36] and those on low back problems and smoking[11, 18, 20, 22, 26, 28, 29, 31, 33, 38] both show conflicting results. A number of psychosocial risk factors appear to be associated with low back problems[13, 18, 29, 32], but these factors are determined from questionnaires and differences in question wording make these factors difficult to interpret and generalize.

Table 2. Studies Examining Prevalence and Risk Factors for Low Back Problems among Vehicle Drivers

| Study | Group/Study Location | Method to Obtain Low Back Problem | Prevalence (Risk Factor Outcome Measure [Where More Than One Prevalence Measure Cited]) | Risk Factor Supported | Risk Factor Not Supported |
|---|---|---|---|---|---|
| Netterstrom and Juel 1989 (18) | 2,465 Male Urban Bus Drivers<br><br>Denmark | Hospital Discharge Records | Hospital Discharge with Low Back Trouble (Mostly Lumbar Disc Herniations) over 7 Years: 2% | Psychosocial<br>- Social Problems Due to Shift Work<br>- Feeling of Monotony<br>- Increased Work Pace Over Time<br>- Feeling Mentally Unbalanced | Education<br>Smoking<br>Pace of Work<br>Marital Status<br>Psychosocial<br>- High Workload<br>- Social Activities With Colleagues<br>- Social Activity in Free Time<br>- Job Satisfaction<br>- Mental Exhaustion<br>- Insomnia<br>- Nervousness<br>- Feeling Exhausted |
| Boshuizen et al. 1990 (23) | 450 Tractor Drivers<br>110 Non-Tractor Drivers | Questionnaire | Regular Back Pain:<br>- Tractor=38%<br>- Non Tractor=27%<br>LBP:<br>- Tractor=31%<br>- Non Tractor=18%<br>Prolapsed Disc:<br>- Tractor=8%<br>- Non Tractor=5%<br><br>(Risk Factor Outcome: LBP) | Years of Vibration Exposure<br>Duration of Vibration Exposure | Vibration Intensity |
| Anderson 1992 (16) | 128 Bus Drivers<br>67 Non Drivers<br><br>California, USA | Physical Examination and Interview | Any Spinal Pain:<br>- Drivers=81%<br>- NonDrivers=51%<br>Lumbar Pain:<br>- Drivers=66%<br>- NonDrivers=45%<br><br>(Risk Factor Outcome appeared to vary: Any Spinal Pain; Back and Neck Pain) | None | Body Weight<br>Exercise<br>Gender<br>Age<br>Handedness<br>Disruption of Sleep<br>Years of Driving |

Table 2. Studies Examining Prevalence and Risk Factors for Low Back Problems among Vehicle Drivers (continued)

| Study | Group/Study Location | Method to Obtain Low Back Problem | Prevalence (Risk Factor Outcome Measure [Where More Than One Prevalence Measure Cited]) | Risk Factor Supported | Risk Factor Not Supported |
|---|---|---|---|---|---|
| Pietri et al. 1992 (25) | 1709 Commercial Travelers (primarily traveling salesmen)<br><br>France | Annual Medical Examination | LBP in Last Year: 27% | Female Gender<br>Older Age<br>Time Driving/Week*<br>Uncomfortable Car Seat<br>Carrying Loads<br>Standing<br>Smoking<br>More Psychosomatic Factors | Not Specified |
| Bovenzi 1992 (11) | 598 Vehicle Drivers (quarry vehicles, forklifts, trucks, buses)<br><br>Italy | Modified Nordic Musculoskeletal Questionnaire | LBP Last Year: 44%<br>High Intensity LBP Last Year: 26%<br>LBP Disability Last Year: 18%<br><br>(Risk Factor Outcome: LBP Last Year) | Age<br>Trunk Bent at Work<br>Trunk Twisted at Work<br>Lifting and Twisting at Work<br>Trunk Bent Forward/Twisted, Driving<br>Daily Vibration Duration*<br>Cumulative Vibration Exposure* | BMI<br>Smoking<br>Drinking<br>Educational Level<br>Physical Activity<br>Car Driving Mileage<br>Previous Job with Vibration Exposure<br>Previous Job with Heavy Loads<br>Sitting Other Than Driving<br>Standing/Walking at Work<br>Lifting at Work >15 kg<br>Job Satisfaction<br>Years of Driving |

Table 2 continued. Studies Examining Prevalence and Risk Factors for Low Back Problems among Vehicle Drivers (continued)

| Study | Group/Study Location | Method to Obtain Low Back Problem | Prevalence (Risk Factor Outcome Measure [Where More Than One Prevalence Measure Cited]) | Risk Factor Supported | Risk Factor Not Supported |
|---|---|---|---|---|---|
| Bovenzi and Zadini 1992 (11) | 234 Male Bus Drivers<br>125 Male Maintenance Workers (Controls)<br><br>Triest, Italy | Modified Nordic Musculoskeletal Questionnaire | Lifetime LBP Symptoms:<br>- Drivers=84%<br>- Control=66%<br>Lifetime Acute LBP:<br>- Drivers=39%<br>- Controls=30%<br>Lifetime LBP:<br>- Drivers=36%<br>- Controls=15%<br>Lifetime Disc Protrusion:<br>- Drivers=8%<br>- Controls=7%<br>12-Month LBP Symptoms:<br>- Drivers=83%<br>- Controls=66%<br>12-Month Acute LBP:<br>- Drivers=35%<br>- Controls24%<br>12-Month LBP:<br>- Drivers=40%<br>- Controls=20%<br>12-Month Treated LBP:<br>- Drivers=61%<br>- Controls=50%<br>7-Day LBP Symptoms:<br>- Drivers=62%<br>- Controls=46%<br><br>(Risk Factor Outcome: 12-Month LBP) | Total Vibration Dose (yrs $m^2/sec^4$)*<br>Awkward Postures* | Age<br>BMI<br>Education<br>Smoking<br>Sports Activity<br>Previous Job with Vibration<br>Previous Heavy Physical Demand |

Table 2 continued. Studies Examining Prevalence and Risk Factors for Low Back Problems among Vehicle Drivers (continued)

| Study | Group/Study Location | Method to Obtain Low Back Problem | Prevalence (Risk Factor Outcome Measure [Where More Than One Prevalence Measure Cited]) | Risk Factor Supported | Risk Factor Not Supported |
|---|---|---|---|---|---|
| Bovenzi and Betta 1994 (20) | 1,155 Tractor Drivers<br>255 Revenue Officers (Controls)<br><br>Italy | Modified Nordic Musculoskeletal Questionnaire | LBP Lifetime:<br>- Tractor=81%<br>- Controls=42%<br>LBP 12-Month:<br>- Tractor=72%<br>- Controls e=37%<br>LBP 1-Month:<br>- Tractor=39%<br>- Controls e=19%<br>Transient LBP:<br>- Tractor=67%<br>- Controls =35%<br>Chronic LBP:<br>- Tractor=37%<br>- Controls =17%<br>Sciatic Pain:<br>- Tractor=16%<br>- Controls =4%<br>Acute LBP:<br>- Tractor=36%<br>- Controls =10%<br>Treated LBP:<br>- Tractor=25%<br>- Controls =18%<br>LBP Sick Leave:<br>- Tractor=12%<br>- Controls =5%<br>Disc Protrusion:<br>- Tractor=7%<br>- Controls =2%<br><br>(Risk Factor Outcome: Lifetime LBP) | Total Vibration Dose (yrs $m^2/sec^4$)*<br>Older Age*<br>Postural Load (4 grades)*<br>Previous Low Back Injury<br>Married | Education<br>Body Mass Index<br>Sports Activity<br>Car Driving<br>Smoking<br>Martial Stratus<br>Previous Jobs |

Table 2 continued. Studies Examining Prevalence and Risk Factors for Low Back Problems among Vehicle Drivers (continued)

| Study | Group/Study Location | Method to Obtain Low Back Problem | Prevalence (Risk Factor Outcome Measure [Where More Than One Prevalence Measure Cited]) | Risk Factor Supported | Risk Factor Not Supported |
|---|---|---|---|---|---|
| Magnusson et al. 1996 (22) | 111 Bus Drivers<br>117 Truck Drivers<br>137 Sedentary Workers<br><br>Sweden and US | Modified Nordic Musculoskeletal Questionnaire | LBP During Present Job:<br>Bus Truck Sedentary<br>US 81% 50% 42%<br>Sweden 49% 59% 42% | Long-Term Vibration Exposure<br>Heavy Lifting<br>Frequent Lifting | Daily Vibration Dose ($m/s^2$Xhr)<br>Overweight<br>Smoking<br>Regular Exercise<br>Marital Status |
| Burton et al. 1996 (40) | 1508 Ulster Police<br>377 Manchester Police | Questionnaire | 1 Episode:<br>- Ulster=11%<br>- Manchester=19%<br>Episodic:<br>- Ulster=59%<br>- Manchester=58%<br>Persistent:<br>- Ulster=31%<br>- Manchester=23%<br><br>(Risk Factor Outcome: First LBP Incidence) | Vibration Exposure<br>Wearing Body Armor<br>Sports Participation | No Other Factors Explored |
| Krause et al. 1997 (30) | 1,463 Transit Operators<br><br>San Francisco, USA | Questionnaire about Current Back or Neck Pain | Current Back or Neck Pain: 15% | More Years of Driving*<br>Hours Driving/Week<br>Body Weight <64 kg<br>BMI>$10^{th}$ Percentile<br>Ergonomic Factors<br>- Seat Adjustment Problems*<br>- Rocking Seats*<br>- Trouble Seeing Out Of Vehicle*<br>- Reaching Across Wheel*<br>- Hard to Reach Controls<br>- Difficulty Breaking | Overtime Driving<br>Vehicle Type<br>Age |
| Krause et al. 1998 (13) | 1,449 Transit Operators<br><br>San Francisco, USA | Workman's Compensation Claims for Low Back Spinal Injury | 5-Year Low Back Spinal Injury: 58% | Female Gender<br>Fewer Years of Driving*<br>Younger Age<br>Psychosocial<br>- Job Problems<br>- High Psychological Demands<br>- Job Dissatisfaction<br>- Part Time Driving<br>- Low Supervisory Support | Hours Driving/Week<br>Height<br>Weight<br>Number of Breaks<br>Psychosocial<br>- Decision Latitude<br>- Job Strain |

Table 2 continued. Studies Examining Prevalence and Risk Factors for Low Back Problems among Vehicle Drivers (continued)

| Study | Group/Study Location | Method to Obtain Low Back Problem | Prevalence (Risk Factor Outcome Measure [Where More Than One Prevalence Measure Cited]) | Risk Factor Supported | Risk Factor Not Supported |
|---|---|---|---|---|---|
| Schwarze et al. 1998 (41) | 65 Non-Drivers<br>159 Fork Lifts Operators<br>64 Truck Drivers<br>165 Heavy Equipment Operators | Interview, clinical exam, lumbar X-ray, health insurance claims | Lumbar Syndrome<br>- Nondrivers: 59%<br>- Fork Lift: 65%<br>- Truck: 63%<br>- Heavy Equipment: 61% | Vibration Dose* | |
| Miyamoto et al. 2000 (31) | 181 Truck Drivers<br><br>Japan | Questionnaire on LBP in last month | LBP in Last Month: 50% | Long Driving Time in a Day<br>Short Resting Time<br>Irregular Duty Time<br>Shortage of Time With Family | Smoking<br>Sports<br>Lack of Sleeping Time<br>Family History of Lumbar Disorders<br>Posture<br>Work Environment<br>Irregular Meal Time<br>Mental Stress in Human Relations |
| Porter and Gyi 2002 (27) | 113 Work Drivers<br>135 Non Divers<br><br>England | Nordic Musculoskeletal Questionnaire | Current LBP:<br>- Drivers=30%<br>- NonDrivers=25%<br>Lifetime LBP:<br>- Drivers=61%<br>- NonDrivers=55%<br>LBP Absence (mean days):<br>- Drivers=16<br>- NonDrivers=2<br><br>(Risk Factor Outcome: LBP Absences) | More Annual Mileage<br>More Hours Driving/Week<br>More Miles Driven/Week<br>Lack of Lumbar Support | Not Stated |
| Krause et al. 2004 (8) | 1,233 Transit Operators<br><br>San Francisco, USA | Incidence of a Compensated Claim of a Low Back Injury over 7.5 Years (ICD-9 Codes) | Compensated Low Back Injury: 27% (331/1,233) | Fewer Years of Driving<br>More Hours Driving/Week<br>Female Gender<br>Ergonomic Problems<br>Vehicle Type (Cable Car) | Height<br>Weight<br>Age<br>Race |
| Chen et al. 2005 (32) | 1242 Taxi Drivers<br>Professional Drivers<br><br>Taipei, Tiawan | Modified Nordic Musculoskeletal Questionnaire | LBP 12-Months:<br>- Drivers=33%<br>- Taxi Drivers=51% | Bending Twisting while Driving*<br>Perceived Job Stress*<br>Job Dissatisfaction*<br>Driving Duration* | Lifting<br>Leisure Physical Activity<br>Years of Taxi Driving |

Table 2 continued. Studies Examining Prevalence and Risk Factors for Low Back Problems among Vehicle Drivers (continued)

| Study | Group/Study Location | Method to Obtain Low Back Problem | Prevalence (Risk Factor Outcome Measure [Where More Than One Prevalence Measure Cited]) | Risk Factor Supported | Risk Factor Not Supported |
|---|---|---|---|---|---|
| Chen et al 2005 (37) | 224 Taxi Drivers<br><br>Taipei, Taiwan | Structured Interview | LBP Leading to Medical Attention or Absence from Driving in Last Month: 25% | Seat Angle <90 degrees<br>Lack of Use of Lumbar Support | Hours of Driving/Month |
| Andrusaitis et al. 2006 (33) | 410 Truck Drivers<br><br>San Paulo, Brazil | Questionnaire asking if subject experienced LBP as a driver | LBP in Experience as a Driver: 59% | More Working Hours | Age<br>Height<br>Weight<br>Body Mass Index<br>Time in Profession<br>Sleep Hours<br>Smoking/Alcohol Consumption<br>Frequency of Physical Activity<br>Ethnic Group |
| Robb and Mansfield 2007 (34) | 192 Truck Drivers<br><br>England | Nordic Musculoskeletal Questionnaire | Lifetime LBP: 70%<br>LBP in Last Year: 60%<br>LBP in Last 7 Days: 24%<br>LBP Affecting Activity: 12%<br><br>(Risk Factor Outcome: Musculoskeletal Problems) | Fewer Miles Driven Week<br>Fewer Hours Driving/Week<br>Daily Heavy Lifting (<10 kg) | Hours of Driving |
| Tamrin et al. 2007 (35) | 760 Bus Drivers<br><br>Malaysia | Nordic Musculoskeletal Questionnaire | Lower Back Musculoskeletal Disorders: 60% | Months with Current Employer<br>Non-Adjusting Steering Wheel<br>Perception of Vibration Exposure<br>Mood States<br>Tension-Anxiety<br>Depression-Dejection<br>Anger-Hostility<br>Fatigue<br>Confusion | Average Hours Driving/Day<br>Average Hours Driven/Week<br>Time to Finish a Trip<br>Total Trips/Day<br>Rest Brakes<br>Days of Rest/Week<br>Magnitude of Vibration<br>Posture<br>Previous Work Experience<br>Previous Driving Experience<br>Part Time Work<br>Adjustable Seat<br>Seat Comfort<br>Help Passengers Carry Loads<br>Peer Support<br>Ability to Rest<br>Accident History<br>Work Hours Based on Shift |

Table 2 continued. Studies Examining Prevalence and Risk Factors for Low Back Problems among Vehicle Drivers (continued)

| Study | Group/Study Location | Method to Obtain Low Back Problem | Prevalence (Risk Factor Outcome Measure [Where More Than One Prevalence Measure Cited]) | Risk Factor Supported | Risk Factor Not Supported |
|---|---|---|---|---|---|
| Miyamoto et al. 2008 (29) | 1,334 Taxi Drivers<br><br>Japan | Roland-Morris Questionnaire | LBP in Last Week: 21% | Previous History of LBP<br>Feeling of Lack of Energy<br>Other Diseases<br>Little Time To Relax at Home<br>Not Sleeping Well<br>Car Vibration<br>Smoking<br>Psychosocial<br>Customer Stress<br>Long Working Hours<br>Lack of Challenging Work<br>Feeling of Heavy Responsibility | Age<br>Gender<br>Height<br>Weight<br>BMI<br>Length of Service<br>Daily Working Hours<br>Monthly Mileage<br>Frequency of Night Shift Work<br>Marital Status |
| Tiemessen et al. 2008 (28) | 229 Male Drivers<br><br>Netherlands | Developed Questionnaire<br>Disability Scale | LBP In Last Year: 58%<br>Driving-Related LBP: 37%<br>(Risk Factor Outcome: Driving-Related LBP) | Daily Driving Time*<br>Years of Vibration Exposure*<br>Daily Duration of Vibration Exposure*<br>Total Vibration Exposure*<br>Previous job with Lifting<br>Previous Back Trauma<br>Posture (Trunk Bent at Work)<br>Lifting at Work<br>Lifting and Bending at Work<br>Lifting and Twisting at Work | Body Mass Index<br>Smoking<br>Marital Status<br>Alcohol Consumption<br>Previous Job with Vibration<br>Back/Trunk Twisted While Driving<br>Job Satisfaction<br>Sitting >3 hours at work |
| Okunribido et al. 2008 (26) | 60 Police<br>65 Tractor Drivers<br>70 Track/Van Drivers<br>68 Bus Drivers<br>34 Construction Drivers<br>30 Taxi Drivers<br>59 Non-Drivers (Controls)<br><br>Location Not Stated | Questionnaire | LBP Last 7 Days / Year<br>Police 19% 46%<br>Tractor Drivers 17% 43%<br>Track/Van Drivers 32% 50%<br>Bus Drivers 31% 59%<br>Construction Drivers 23% 44%<br>Taxi Drivers 44% 63%<br>Non-Drivers (Controls) 37% 58%<br><br>(Risk Factor Outcome: LBP Last Year) | Past LBP<br>Tobacco Use<br>Discomfort From To Driving<br>Fast Driving Style<br>Posture<br>Awkward Lifting | Female gender<br>Age<br>BMI<br>Educational Level<br>Physical Activity (Exercise)<br>Lifting Heavy or Light Loads |

Legend: LBP=Low back pain; US=United States; BMI=Body mass index
Notes:
*Dose-Response Found

c. Vibration Exposure and Low Back Problems. One potential risk factor for LBP that has received considerable interest is vibration exposure. Vibration exposure has been studied in the laboratory to understand how it might be related to back problems and in epidemiological studies among vehicle drivers exposed to various types of vibration to understand the magnitude of the back injury risk.

(1) Vibration Physics and Musculoskeletal Activity

(a) Vibration is the oscillation of an object about an equilibrium point. Figure 1 shows a vibrating object moving back and forth from a stationary position. The vibration of this object or any object can be described in terms of frequency, amplitude and acceleration. Frequency is the number of cycles completed in one second. Hertz (Hz) is the measure of frequency and is defined as the number of cycles per second. Amplitude, which is the distance the object moves, in meters, provides a measure of the intensity of the vibration. Acceleration, measured in meters/second$^2$, is how quickly the speed of the vibrating object changes over time. The speed at which an object vibrates varies. Speed, measured in meters/sec, is most rapid as the object moves through the midpoint of the cycle and slowest as the object reaches the extreme. At each extreme, speed reaches zero as the object reverses direction[42].

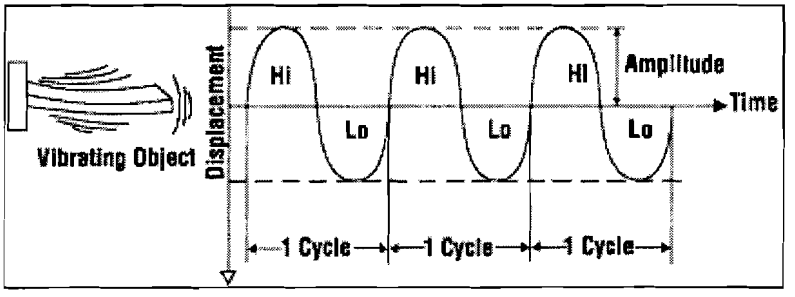



Figure 1. Characteristics of a Vibrating Object[42]

(b) A vibrating object will produce greater oscillations at particular frequencies than at others. These frequencies are known as the object's resonance frequencies. The resonance frequencies of an object depend on its size, weight, stiffness, and structure. A maximum amount of energy is produced at the resonance frequencies and structures vibrating at these frequencies experience the greatest stresses and strains[43]. Studies of various types of motor vehicles have reported peak vibration frequencies in the range of 1–8 Hz, with peak accelerations ranging from 0.7 to 25.6 m/sec$^2$ [44-47]. However, vibrations occur over a wide range of frequencies, up to at least 80 Hz[46]. Acceleration, measured in samples of civilian buses, trucks, and truck tractors, have ranged from 0.24 to 8.0 m/sec$^2$, although in most cases average accelerations along a single axis (x, y, or z) do not exceed 1 m/sec$^2$, as shown in Table 3[11, 20, 45-48]. Studies frequently report the "vector sum of frequency-weighted root mean square," which is calculated as

$\Sigma[(1.4a_{xw})^2+(1.4a_{yw})^2+a_{zw}{}^2]^{0.5}$ where $a_{xw}$, $a_{yw}$, and $a_{xw}$ are the frequency weighted accelerations along the x, y, and z axis, respectively[20, 47]. These are also shown in Table 3 for the reported studies. International Standards Organization Standard Number 2631-1 (ISO 2631-1) prescribes recommended human exposure times based on the vector sum of frequency-weighted root mean square.

Table 3. Frequency-Weighted Accelerations in Various Vehicles

| Study | Vehicle | Road Conditions | Location of Accelerometer | Average Accelerations (m/sec$^2$) Mean±SD or Mean Only (if SD not provided in article) | | | Vector Sum of Frequency Weighted Accelerations (m/sec$^2$)[a] |
|---|---|---|---|---|---|---|---|
| | | | | x-axis (front-back; sagittal) | y-axis (left-right; coronal) | z-axis (up-down; vertical) | |
| Johanning et al. 1991 (49) | Subway Cars, New York City | subway rails | seat pan, under driver | 0.10 | 0.26 | 0.37 | 0.54 |
| Hampel and Chang 1999 (46) | Truck Tractor (cab over engine) | secondary roads | seat pan | 0.32±0.06 | 0.29±0.03 | 0.89±0.08 | 1.08 |
| Kumar 2004 (48) | Heavy Hauling Trucks (300-400 tons unloaded) | frozen roads, smooth, hauling to dump sites | seat pan | 0.51±1.27 | 0.48±1.28 | 0.79±0.72 | 1.13 |
| | | | lumbar area | 0.81±0.58 | 0.52±0.34 | 0.73±0.33 | |
| Funakoshi et al. 2004 (47) | Taxis (Nissan Crew; Toyota Crew) | paved roads, Fukuoka Japan | seat pan | 0.16±0.03 | 0.16±002 | 0.31±0.02 | 0.44 |
| Cann et al 2004 (50) | Cab Over Truck | major highways, northern Ontario | seat pan | 0.19±0.06 | 0.18±0.06 | 0.33±0.15 | 0.51±0.15 |
| | Cab Behind Truck | | | 0.19±0.07 | 0.21±0.08 | 0.48±0.19 | 0.64±0.22 |
| | Rough Roads | | | 0.24±0.07 | 0.24±0.08 | 0.52±0.20 | 0.73±0.21 |
| | Smooth Roads | | | 0.12±0.03 | 0.15±0.03 | 0.35±0.14 | 0.47±0.11 |
| Okunribido et al. 2007 (45) | Volvo Single Decker Bus | asphalt | seat, below driver's ischial tuberosities | 0.19 | 0.24 | 0.42 | 0.38 |
| | Leyland Double Decker Bus | | | 0.23 | 0.24 | 0.18 | 0.48 |
| | Mercedes Mini-Bus | | | 0.18 | 0.18 | 0.22 | 0.59 |
| Okunribido et al. 2008 (26) | Tractor | not specified | seat, below driver's ischial tuberosities | 0.48 | 0.49 | 0.48 | 0.95 |
| | Harvester | | | 0.22 | 0.22 | 0.39 | 0.53 |
| | All Terrain Bike | | | 0.37 | 0.39 | 0.64 | 0.90 |
| | Car | | | 0.12 | 0.07 | 0.13 | 0.21 |
| | Euro Taxi | | | 0.31 | 0.23 | 0.46 | 0.65 |
| | Van | | | 0.26 | 0.25 | 0.35 | 0.54 |
| | Bus | | | 0.25 | 0.32 | 0.48 | 0.68 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Dumper | | | 0.32 | 0.41 | 0.43 | 0.76 |
| | Loading Shovel | | | 0.54 | 0.54 | 0.44 | 1.00 |
| | Bobcat | | | 0.81 | 0.77 | 0.99 | 1.66 |
| | Fort Lift Truck | | | 0.24 | 0.18 | 0.21 | 0.41 |
| Bovenzi (38) | Quarry Loader | not specified | seat pan | 0.21±0.04 | 0.25±0.06 | 0.35±0.09 | 0.57±0.11 |
| | Quarry Excavator | | | 0.24±0.10 | 0.20±0.10 | 0.52±0.11 | 0.69±0.19 |
| | Quarry Crusher | | | 0.07±0.01 | 0.07±0.02 | 0.66±0.07 | 0.67±0.12 |
| | Marble Crane | | | 0.06±0.01 | 0.07±0.02 | 0.29±0.06 | 0.32±0.06 |
| | Marble Fork Lift | | | 0.30±0.03 | 0.28±0.07 | 0.95±0.12 | 1.10±0.10 |
| | Mill Fork Lift | | | 0.11±0.02 | 0.11±0.02 | 0.30±0.05 | 0.37±0.04 |
| | Garbage Truck | | | 0.10±0.02 | 0.10±0.02 | 0.24±0.03 | 0.31±0.03 |
| | Bus | | | 0.07±0.02 | 0.09±0.04 | 0.30±0.09 | 0.34±0.10 |

Notes:
[a]As provided in article or calculated as $\Sigma\,[(1.4a_{xw})^2+(1.4a_{yw})^2+a_{zw}^2]^{0.5}$

(c) In motor vehicles, vibration originates from the engine and the movement of wheels on different surfaces. Vibration frequencies and accelerations will change as a result of road irregularities (jolts/shocks), vehicle speed, and gear shift changes. Vibration is transmitted through the vehicle frame and the seat to the driver's buttocks and spine. If vibration experienced by the body occurs at the resonance frequency of a body tissue, then a maximum amount of energy can be repetitively transferred to that body tissue, possibly increasing the likelihood of overuse injury over time. The resonance frequencies recorded at the lumbosacral spine in the seated position are in the ranges of 4 to 6 Hz and 10 to 14 Hz[51-53]. Thus, the frequencies at which motor vehicles vibrate are within the resonance frequencies of the human spine, providing for a maximum transfer of vibration energy to the spine and allowing for the possibility of overuse injury through this transfer. The first resonance frequency range (4 to 6 Hz) appears to be due to the upper torso vibrating vertically with respect to the pelvis; the second resonance frequency range (10 to 14 Hz) appears to be due to a bending vibration of the upper torso with respect to the spine[51].

(d) During laboratory studies involving vibration, higher spinal torques were produced at frequencies of 3 to 10 Hz compared with static sitting. The highest spinal torques were recorded at about 4 Hz[54]. At 4 Hz, electromyographic (EMG) activity increased over 30 min, but at 8 Hz no increase was seen in standing subjects[55]. These data suggest that, at spinal resonance, there is greater muscular activity than at other frequencies. Hanson et al.[56] showed that when seated subjects were leaning forward and exposed to 5 Hz vibration at 2 m/sec$^2$ for 5 minutes, EMG frequency at the lumbar spine shifted to lower frequencies. EMG shifts from higher to lower power frequencies suggest fast twitch muscle fibers are recruited less and slow twitch recruited to a larger extent; this shift has been shown to indicate a fatiguing effect[57, 58]. The study by

Hanson et al.[56] is often cited (e.g., [51, 59, 60]) as evidence that vibration is associated with fatigue of the spinal muscle; however, motor vehicle operators seldom lean forward while driving. In a study involving 3.5 hours of actual driving in a midsized sedan at several different seat inclinations and with lumbar supports of various thicknesses, there was no shift in the EMG power frequency in the lumbar area that would have indicated fatigue[61]. In response to transient whole-body vibration (similar to road shocks) EMG activity transiently increased[62], but quickly returned to baseline resting activity. Repeated "shock" cycles could induce fatigue over a long period of time, but it is also likely that a muscle conditioning effect (improved muscular endurance) could occur among drivers exposed to continuous road vibrations or shock cycles.

(e) EMGs measured during vibration showed time lags between vibration displacement and peak muscle torques that vary between 30 and 100 msec at vibration frequencies of 3 and 10 Hz[54]. This time lag may cause muscles to add to the effects of vibration (in terms of spinal stress), rather than dampen them, since the muscle contraction would be out of phase with the vibration[51].

(f) In vivo studies with dissected cat spines show that cyclic spinal loading results in a gradual decline in muscular activity of the lumbar multifidus muscles accounted for by mechanoreceptor desensitization due to induced "creep" or laxity in the viscoelastic tissues (ligaments, discs, joint capsule)[63-65]. Muscles may thus become less active in stabilizing spinal movements when exposed to repetitive cyclic loading under these conditions. However, studies showing these effects were carried out at frequencies of 0.25–0.5 Hz, much lower than that expected for vehicle vibration. Studies using in vivo spinal porcine models and vibration frequencies of 5 Hz also demonstrated viscoelastic creep behavior, but EMGs were not obtained[66].

(g) Body height changes in response to 5 Hz whole body vibration were reported in studies in laboratory settings[60]. This suggests a compression of the spinal discs that could be associated with disc problems. However, other studies have seen a slight increase in stature following vibration exposure[46, 67], so the significance of these findings are not clear.

(h) Vibration appears to have only minor effects on cardiorespiratory measures in seated individuals. Vibration frequencies of 3, 4.5, and 6 Hz with 0.9 m/sec$^2$ vertical (z-axis) accelerations were studied in 13 seated young men (age 25±4 years). There was a slight increase in oxygen consumption from rest to vibration but increasing frequencies did not further influence oxygen consumption. While stroke volume declined slightly between 3 and 4.5 Hz (88±17 versus 84±18 ml/beat, p=0.01), there were no other significant vibration effects on heart rate, ventilation rate, respiratory frequency, or tidal volume[68].

(2) Epidemiological Studies

(a) Three systematic reviews have been conducted on the relationship between whole body vibration exposure and LBP[69-71]. The first review[69], published in 1987, found that studies had limited methodological quality, lack of control for confounders (e.g., posture, lifting of heavy loads, age), and only two studies had actually measured the amount of vibration in other than years of potential exposure. Nonetheless, all the studies suggested that long-term exposure to vibration was harmful to the spinal system, although a dose-response relationship could not be established at that time.

(b) The next systematic review was published 12 years later (1999) and performed several meta-analyses on the association between various low back problems and driving-related whole body vibration[70]. Table 4 shows the prevalence odds ratios or incidence density ratios for various low back problems in individuals exposed to whole body vibration. These data suggested that whole body vibration from vehicle driving was associated with LBP, sciatic pain and, to a lesser extent, lumbar disc disorders. Three studies[20, 23, 41] included in the review measured vehicle vibration and showed a dose response such that the prevalence of LBP increased with increasing exposure to whole body vibration. The results of two of these studies are plotted in Figure 2. Note that the units of whole body vibration dose are years $m^2/sec^4$; this is the dose received while driving 1 year in a vehicle with a whole body vibration level of 1 $m/sec^2$ [39]. The two studies of tractor drivers in Figure 2 suggested a dose-response relationship: the prevalence odds ratios increased with an increase in the estimated lifetime cumulative whole body vibration exposure.

Table 4. Meta-Analysis on the Association Between Various Low Back Problems and Exposure to Vehicle Whole Body Vibration (From Bovenzi and Hulshof, 1999[70])

| Disorder | Studies (n) | Summary Prevalence Odds Ratio (Vibration Exposed / Unexposed) | Summary Incidence Density Ratio (Vibration Exposed / Unexposed) | Summary 95% Confidence Intervals |
|---|---|---|---|---|
| Low Back Pain | 9 | 2.3 | A | 1.8–2.9 |
| Sciatic Pain | 7 | 2.0 | A | 1.3–2.9 |
| Herniated Lumbar Disc | 4 | 1.5 | A | 0.9–2.4 |
| Back Disorders | 3 | a | 1.3 | 0.9–1.7 |
| Lumbar Disc Disorders | 3 | a | 1.8 | 1.1–3.1 |

Notes:
a.Not evaluated

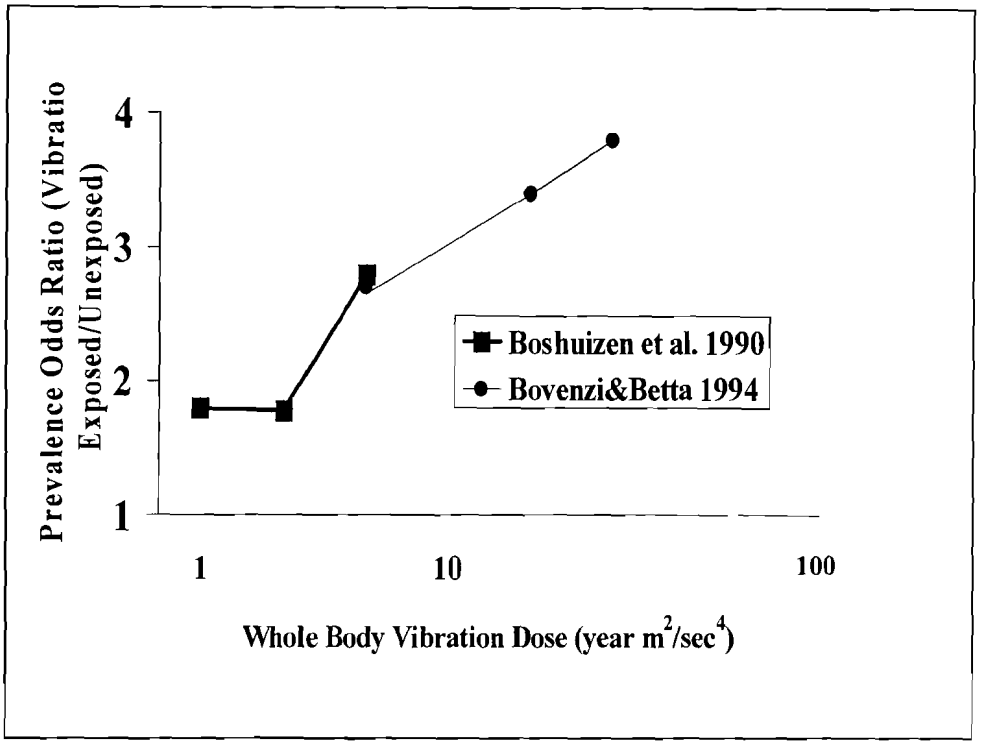



Figure 2. Prevalence Odds Ratios for Low Back Pain among Tractor Drivers as a Function of Whole Body Vibration Exposure (Bovenzi and Hulshof 1999[70])

(c) The most recent systematic review[71] published in 2000 concluded, from 6 studies that met their quality criteria, that there was a positive relationship between whole body vibration exposure and LBP. Of four studies reporting the vibration dose, two showed a dose-response relationship. However, the authors stated that it was not possible to determine if vibration exposure alone caused LBP or if vibration exposure was a risk factor in combination with other factors (e.g., awkward postures, prolonged sitting). However, another systematic review performed by these same authors indicated that sitting at work, by itself, was not associated with LBP[72].

(d) Since the three systematic reviews were conducted, three additional studies[26, 28, 38] have examined the dose-response between whole body vibration from vehicle driving and LBP. In one study[28], male drivers (n=229) from 13 different European companies were followed for 1 year and vibration measurements (accelerations) were made on samples of their vehicles. Drivers reported (1) overall LBP during the year and (2) driving-related LBP. While there was little association between self-reported LBP over the last 12 months and whole body vibration exposure, *driving-related* LBP increased with either more years of exposure, more daily hours of exposure, or greater total vibration dose, as shown in Figure 3.

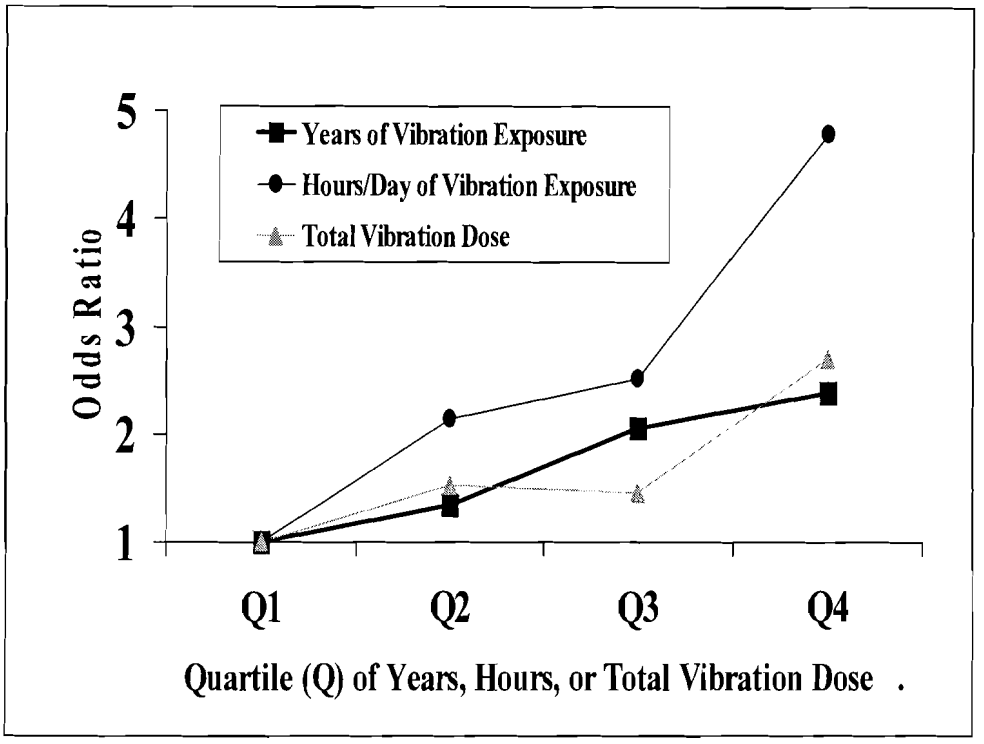



Figure 3. Association Between Measures of Whole Body Vibration Exposure and Driving-Related Low Back Pain in Previous 12 Months (Tiemessen et al. 2008[28])

(e) In the other study[26], questionnaires were sent out to a variety of drivers including police drivers, tractor drivers, truck/van drivers, bus drivers, construction drivers, and taxi drivers. A sample of nondrivers (students, nurses, off-shore workers, city councilors) served as controls. Vibration (accelerometer) measurements were made on samples of vehicles driven. Results indicated that as the total estimated vibration dose increased, so did the risk of self-reported LBP in the previous year, as shown in Figure 4 (p for trend=0.04). The association between the total vibration dose and LBP in the last 7 days was not as clear.

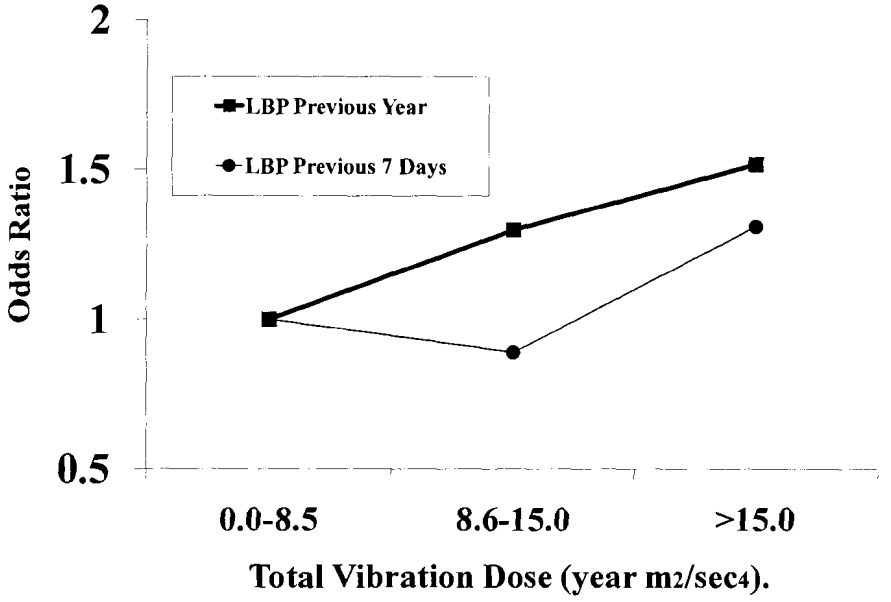



Figure 4. Association between Measures of Cumulative Whole Body Vibration Exposure and Low Back Pain (LBP) in Past 7 Days and Previous Year (Okunribido et al. 2008[26])

(f) In the third and final study, Bovenzi[38] administered questionnaires to 598 drivers involved in quarry operations, truck driving, bus diving and fork lift operations. LBP was measured with the Nordic Musculoskeletal Questionnaire and vibration was measured in a large number of vehicles. LBP was related to a large number of vibration exposure measurements including (1) the 8-hour frequency weighted root mean square acceleration, (2) vibration dose, and (3) cumulative vibration dose. Eight-hour frequency weighted root mean square acceleration was defined as

$$(\Sigma\, a^2_{wi(rms)} X\, t_{di}/T_{(8)})^{0.5}$$

where $a^2_{wi(rms)}$ is the weighted root mean square acceleration of vehicle i, $t_{di}$ is the daily driving hours on vehicle i, and $T_{(8)}$ is the 8 hour time period. Vibration dose was calculated as

$$a_{wi(rmq)} X\, (t_{di} X\, 3600)^{0.25}$$

where $a_{wi(rms)}$ is the weighted root mean quads ($4^{th}$ power) acceleration of vehicle i and $t_{di}$ is the daily driving hours on vehicle i. Cumulative vibration dose was calculated as

$$\Sigma a_{wsi} X t_i$$

where $a_{wsi}$ is the root mean square value of the frequency-weighted accelerations measured on vehicle i and $t_i$ is the time driving (hours/day X days/year X years). Figure 5 shows that there was increased risk of LBP with greater cumulative vibration exposure or more hours/day of vibration exposure. A prospective portion of the study showed that professional drivers with vibration exposure were at risk for developing low back symptoms over a 1–2 year follow-up period.

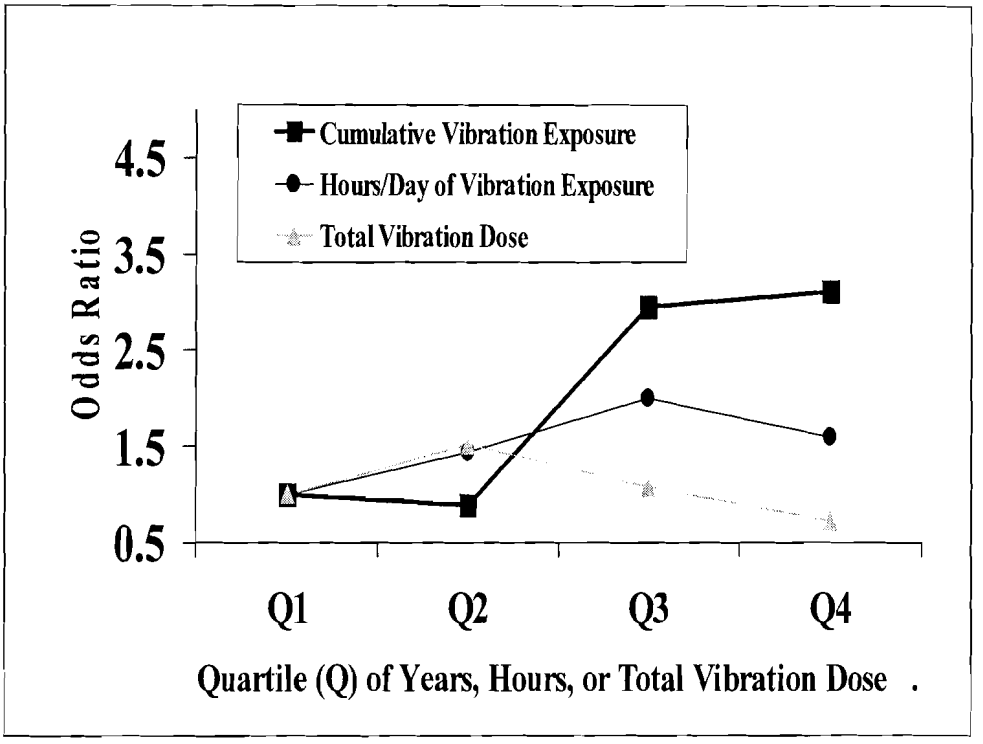



Figure 5. Association between Measures of Whole Body Vibration Exposure and Driving-Related Low Back Pain in Previous 12 Months[11]

(g) In summary, low back problems were generally associated with the total lifetime vibration dose estimated from samples of vehicles driven[11, 20, 22, 23, 26, 38]. The effects of the daily vibration dose or the intensity of the vibration was less clear[22, 23, 35, 38].

d. Backrests and Lumbar Supports

(1) A backrest presumably increases comfort by relaxing the erector spinae muscles, thereby reducing stress on the lumbar spine[73]. Compared with no backrest, a chair with a backrest reduced back pressures by 20%[74]. Inclining the seat had little effect on lordosis, although there was a decrease in disc pressures and electromyographic activity likely due to a transfer of the trunk weight to the backrest[75, 76]. During vibration (3–6 Hz, 0.9 m/sec$^2$), heart rate was higher when seated without a backrest compared with seated with a backrest, suggesting higher energy expenditure without the backrest[68]. This higher energy expenditure may have been from muscular activity necessary to stabilize the trunk.

(2) Biomechanical studies have shown that lumbar supports tilt the pelvis anteriorly and the trunk posteriorly so that the lumbar spine moves toward greater lordosis[75-77]. Individuals report a reduction in back pain when assuming a lordotic posture for a period of time but an increase in back pain when assuming kyphotic posture for a period of time[78]. Studies of lumbar supports of varying thicknesses showed that a pad of 3 cm thickness was rated more comfortable than a standard 6 cm pad or a 9 cm pad. Anthropometric characteristics of subjects did not affect this comfort rating[74].

(3) Studies of individuals in car seats both with and without actual driving showed that there was minimal lumbothoracic muscle activity (EMGs) and the lowest disc pressures when backrests were inclined at 120–130 degrees and lumbar supports were 5 cm in thickness. There was little difference between lumbar supports of 3 and 5 cm thicknesses[61, 79]. Individual differences were noted in one study involving actual sedan driving with some subjects demonstrating minimal EMGs at 100 and 110 degrees of inclination[61]. A study using single impact vibrations (6 m/sec$^2$) showed that backrests reclined at angles of 110 and 120 degrees caused a slight attenuation of vertical vibration[80]. However, this study involved only three subjects and it was not clear if the backrest had a lumbar support. An experimental car seat that was inclined 120 degrees backward and had a lumbar support was shown to reduce vertical (z-axis) accelerations of the lumbar spine and ischial tuberosities by 32% and 20%, respectively, when compared with a standard car seat. The experimental seat also reduced the total vibration dose in lumbar spine and ischial tuberosities by 43% and 35%, respectively, when driving on an expressway. With the experimental seat, seating pressure was transferred from the rear of the seat (reflecting a reduction in ischial tuberosity pressure) to the anterior portion of the seat (reflecting an increase in thigh pressure)[81, 82].

(4) Available epidemiologic evidence indicates benefits from the use of a lumbar support in conjunction with backrests. Drivers of cars with lumbar supports reported fewer days absent from work with low back trouble[27] and/or less LBP requiring medical attention or absence from work[37].

e. Sliding Seats. Seats that move vertically on sliding rails attenuate transient vibration and total vibration dose, as well as increasing comfort[83, 84]. Compared with fixed seats, vertically sliding seats may reduce repeated spinal extension and compression associated with road shocks[84].

f. Seat Cushions

(1) There have been several evaluations of seat cushions examining pressure distribution, comfort, and vibration exposures. No studies were found examining the effects of seat cushions on low back problems.

(2) Seat cushions that are softer (less stiff) and that are contoured result in lower buttocks pressures when seated. Compared to stiffer material, soft material will presumably more effectively wrap around the buttocks and distribute the pressure over a larger surface area. Contoured material will further distribute the weight of the buttocks[85]. However, extensive testing in static seats, during simulated driving conditions and in actual road conditions, have shown that seat interface pressures alone are not associated with comfort ratings[74, 86, 87].

(3) One group of investigators has divided seat cushion comfort into two types: static comfort and dynamic comfort. Static comfort refers to the comfort evaluation of the seated person when seated quietly; dynamic comfort refers to the comfort evaluation of an individual while exposed to vibration, as in a moving vehicle[88]. In static seat cushion evaluations, polyurethane foams that did not bottom out, had lower stiffness, and produced the least pressure at the ischial tuberosities were considered the most comfortable[88, 89]. In dynamic evaluations, comfort ratings differed depending on the vibration frequency. At 5.5 Hz, thicker polyurethane cushions (50, 70, 100 and 120 mm were tested) had progressively lower vibration transmissibility and were judged progressively more comfortable than thinner cushions. At 2.5 Hz, thinner cushions had lower vibration transmissibility and were judged more comfortable. As the intensity of the vibration increased, discomfort increased and cushions with less stiffness were judged slightly more comfortable[90].

(4) A study[91] of foam- and air-filled seat cushions during simulated flying in a Apache helicopter showed that air-filled and foam-filled seat cushions attenuate high and low frequency vibration and resulted in greater subjective comfort and vibration-reduction scores when compared with the standard Apache seat. However, the standard seat and the type of foam used were not described in the article.

(5) Another study[92] examined changes in the vibration frequency and amplitude response to various seat cushion materials. Vibration was induced by impacts delivered to a suspended platform on which subjects were seated; vibration was measured at the platform. A platform without a cushion produced the highest vibration amplitude at 5 Hz, with amplitude attenuation

peaks at 8 Hz. Soft polyethylene cushions (less stiff) produced the highest vibration amplitude at 3 Hz, with amplitude attenuation beginning at 5 Hz and continuing at all frequencies beyond (up to 32 Hz). Stiffer polyethylene cushions produced the highest vibration amplitude at 4 Hz, with amplitude attenuation beginning at 6 Hz and continuing at all frequencies beyond. A viscoelastic cushion produced the highest vibration amplitude at 5 Hz, with amplitude attenuation beginning at 6 Hz and continuing at all frequencies beyond. The maximal amplitude was similar for all conditions.

(6) A study[93] examined the effects of air-filled seat cushions on vibration attention. Seat cushions examined included square and pyramidal air sacs with varying heights and stiffness coefficients as shown in Table 5. Only three subjects, with body weights of 55 kg, 71 kg, and 95 kg, were tested. Results were reported in terms of vibration transmissibility (cushion/no cushion) in frequency ranges from 1 to 10 Hz. Regardless of the type of cushion, the results varied by subject body weight. For the lightest subject (55 kg) there was an increase in vibration transmissibility regardless of frequency. For the 71 kg subject, vibration transmissibility decreased in the 3–4 Hz range, but was higher for most other frequencies. For the 95 kg subject, transmissibility was lower for most pads in the 3–10 Hz range.

Table 5. Characteristics of Tested Seat Cushions (From Huston et al.[93])

| Cushion | Height (mm) | Air Sac Profile | Stiffness (kN/m) |
|---|---|---|---|
| 1 | 25 | Square | 131 |
| 2 | 50 | Pyramid | 120 |
| 3 | 75 | Pyramid | 111 |
| 4 | 75 | Square | 86 |
| 5 | 100 | Pyramid | 75 |

g. Background Summary

(1) Data from the Defense Medical Epidemiological Database (DMED) indicate that Army drivers have a 24% higher rate of low back problems compared with the rest of the Army. This is generally consistent with population surveys of workers in the US and Canada, which show that individuals in transportation occupations have 1.6 to 2.7 times the prevalence of low back problems compared with population averages. Twelve-month prevalence estimates for any LBP range from 27% for commercial travelers to 83% for bus drivers; 7-day prevalence estimates for LBP range from 17% for tractor drivers to 62% for bus drivers. Studies that compared vehicle drivers with nondrivers have shown a higher incidence of low back problems among drivers regardless of case definition or survey period.

(2) Studies that examined risk factors for low back problems among vehicle drivers are complicated by methodological differences, which include different types of vehicles (e.g., bus, tractor, taxi), different data collection methods (e.g., interview, questionnaire, workman's

compensation claims), and different case definitions of low back problems (e.g., any LBP, lumbar disc herniations, spinal injury). Consistently identified risk factors include lifting at work in association with driving and prior low back problems. Less consistently demonstrated risk factors include more driving exposure, awkward postures, bending and twisting while driving, gender, and smoking. Generally, physical characteristics like height, weight, and body mass index (BMI) have not been shown to be associated with low back problems in drivers. Sedentary workers have a higher prevalence of chronic back pain with age, while back pain decreased in drivers with age. This may suggest that drivers who developed back pain left the profession and took up more sedentary jobs.

(3) One risk factor that has received considerable interest is vibration exposure. In motor vehicles, vibration originates from the engine and the movement of wheels on different surfaces. Vibration is transmitted through the vehicle frame and the seat to the driver's buttocks and spine. The resonance frequencies of the lumbosacral spine in the seated position are in the ranges of 4 to 6 Hz and 10 to 14 Hz. Motor vehicles vibrate in this range and this allows for the possibility of overuse injury through vibration transfer. Although spinal muscles are active to stabilize the spine during vibration, it is not clear if vibration induces muscular fatigue over time. Muscular fatigue could reduce the spinal stabilizing effect and increase the likelihood of spinal injury. EMGs measured during vibration showed time lags between vibration displacement and peak muscle torques. This time lag could add to the effects of vibration rather than dampen them, since the muscle contraction would be out of phase with the vibration. Three systematic reviews and three more recent studies of epidemiological investigations generally concluded that there is an association between long-term whole body vibration exposure and LBP. Whether or not there is a dose-responses relationship is not clear.

(4) Studies of lumbar and thoracic EMGs showed that there is minimal muscle activity when seat backrests are inclined 120–130 degrees and lumbar supports are 3 to 5 cm in thickness. Car seats that incline 120 degrees backward and have a lumbar support reduced vertical accelerations and the total vibration dose to the lumbar spine and ischial tuberosities when driving on an expressway. Drivers of cars with lumbar supports report fewer days absent from work with low back trouble and/or less LBP requiring medical attention or absence from work.

(5) Seat cushions that are softer (less stiff) and contoured result in lower buttocks pressures. However, seat interface pressures alone are not associated with comfort ratings. Comfort ratings differ depending on vibration frequency. At 5.5 Hz, thicker polyurethane cushions are judged more comfortable. At 2.5 Hz, thinner cushions are judged more comfortable. As the intensity of the vibration increases, discomfort increased and cushions with less stiffness are judged slightly more comfortable. Vibration amplitude varies depending on the seat cushion material. Soft polyethylene cushions (less stiff) produced the highest vibration amplitude at 3 Hz with amplitude attenuation beginning at 5 Hz and continuing at higher

frequencies. Stiffer polyethylene cushions produced the highest vibration amplitude at 4 Hz, with amplitude attenuation beginning at 6 Hz and continuing at higher frequencies. A viscoelastic cushion produces the highest vibration amplitude at 5 Hz, with amplitude attenuation beginning at 6 Hz and continuing at higher frequencies. Air-filled seat cushions may have different vibration transmissibility effects depending on body weight.

6. METHODS. The 4th Sustainment Brigade at Camp Arifjan, Kuwait, selected drivers in two companies to participate in the project. DSOC funds for seat pads were not available for every driver, so drivers in one company were issued the seat pads (SP group) while drivers in another company were not issued seat pads (NSP group). All selected soldiers were drivers or passengers, primarily in High Mobility Multipurpose Wheeled Vehicle (HMMWV) providing security in support of Heavy Equipment Transport Systems (HETS) during missions through Kuwait into Iraq. Most missions involved multiple days with overnight stops at fixed forward operating bases.

a. Seat Pads. The Skydex® seat pad is shown in Figure 6. The pad consisted of a fabric material that covered a lumbar support and also covered proprietary cushioning composed of plastic ellipses or squares. The lumbar support was 5 cm in thickness. The plastic ellipses or squares were composed of thermoplastic polyurethane, as shown in Figure 7. Data from Skydex® impact testing on military vehicle seats indicated a reduction in impact energy (acceleration) transferred to the top of the seat pad when compared with the standard military vehicle seat[94].

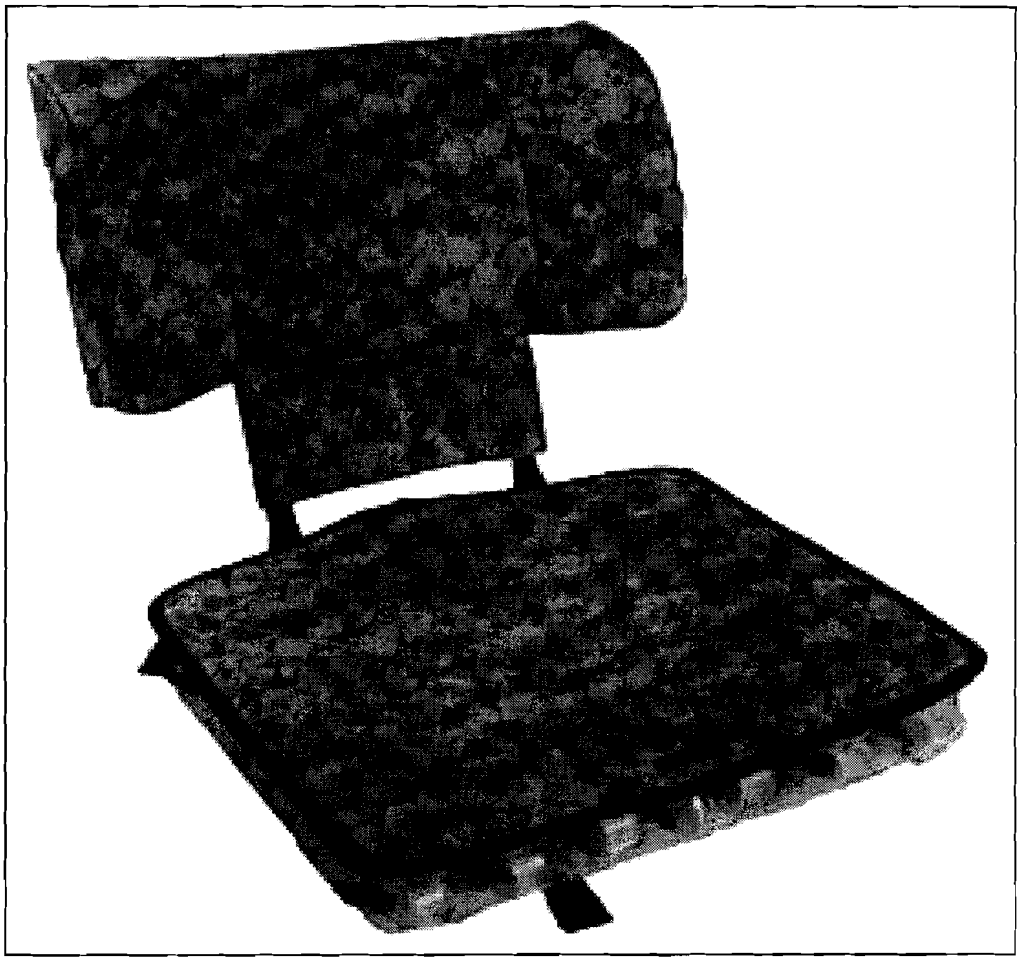
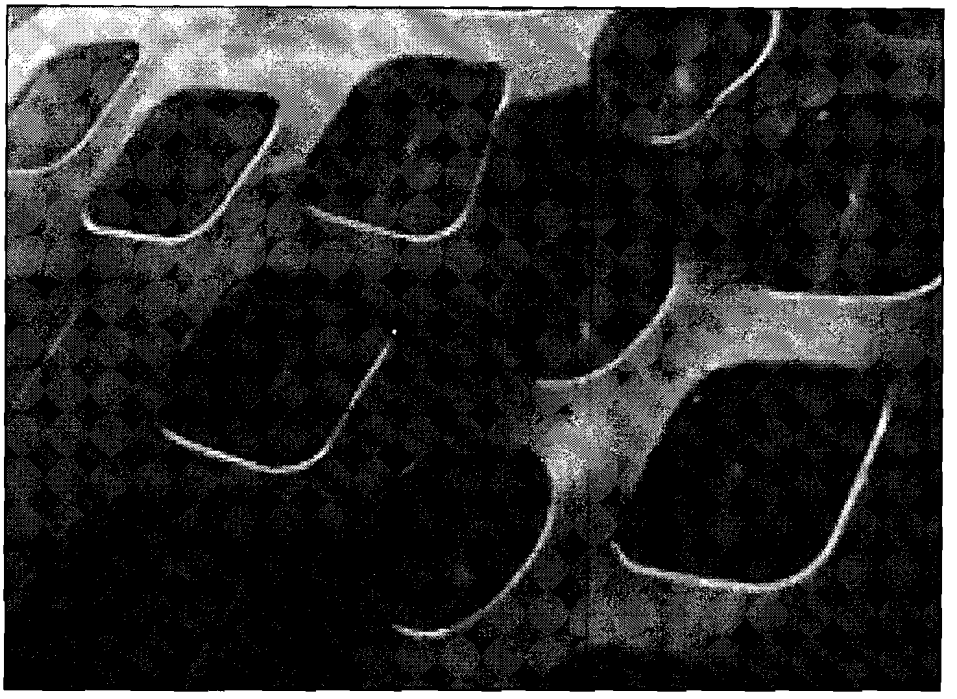
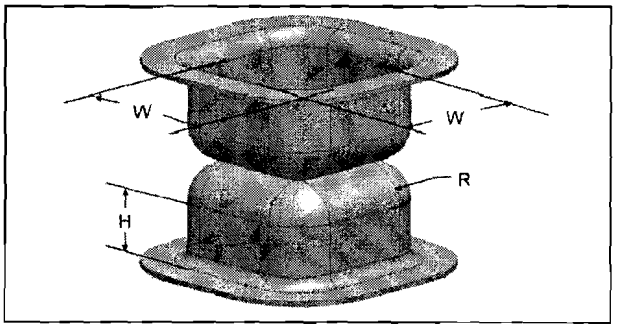


Figure 6. The Seat Pad Showing Lumbar Support and Underlying Cushioning Elements





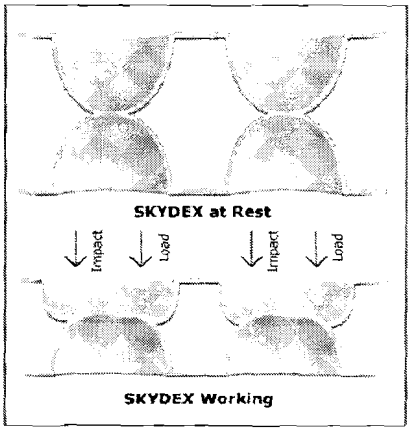




Figure 7. The Cushioning Elements in the Seat Pad

b. Project Design. The project had two phases: a pre-intervention period and an intervention period. In the pre-intervention period, a background questionnaire was administered to both the NSP and SP groups. Seat pads where then distributed to the SP group. During the intervention period, both SP and NSP group members were asked to fill out a questionnaire on completion of their driving missions. About 6 months after the start of the project, a final post-project questionnaire was completed. Descriptions of the questionnaires follow.

c. Background Questionnaire. The background survey was administered to both groups between 17 and 28 October 2008. The survey requested information on Soldier physical characteristics, physical activity, physical fitness, tobacco use, injuries and back pain (last 7 days and last 6 months), prior work history, and conditions in the current deployment. The background survey is in Appendix D.

d. Mission Survey. At the completion of each driving mission during the intervention period Soldiers were asked to complete a mission survey. The mission survey asked Soldiers about driving duration, total miles driven, road conditions, pain/discomfort in various body regions, and effectiveness of the seat pad in increasing comfort, reducing vibration, and influencing back pain. The mission survey is in Appendix E.

e. Post-Project Survey. At the conclusion of the evaluation period, drivers in both groups were asked to complete a post-project questionnaire. The questionnaire was administered between 4 and 7 May 2009. The items on the post-project questionnaire duplicated many of the questions on the baseline questionnaire but asked specifically about the intervention period. The post-project questionnaire is in Appendix F.

f. Final Focus Group Session. After the Soldiers in the SP group had completed the post-project questionnaire they were asked as a group what they (1) liked about the seat pads and (2) what improvements they would suggest. This was an informal and open-ended session.

g. Statistical Analysis

(1) Age was calculated from the date of birth on the questionnaire to the date of the beginning of the project. Body mass index (BMI) was calculated as weight/height$^{2}$ [95].

(2) Most questions on the background questionnaire and post-project questionnaire were identical or similar to allow for comparisons of responses in the pre-intervention and intervention periods. For discrete and nominal variables involving only a 2 × 2 comparison (e.g., groups × yes/no), the Fisher Exact Test was used. For nominal or ordinal variables having more than two levels (e.g., groups × no pain/periodic pain/constant pain), the chi-square statistic was used. Where the questions involved continuous variables, a two-way mixed model analysis of variance was used (groups × intervention period) with repeated measures on the pre-intervention / intervention period. Other statistics (e.g., Mann-Whitney U test, t-test) were used as appropriate and are cited in the text. Where a measure was obtained only on the Background survey, the two groups were compared using the Fisher Exact Test, chi-square statistic, or t-test, as appropriate.

(3) Mission questionnaires were analyzed by comparing the two groups using primarily t-tests. On the question involving pain before and after the driving mission, a two-way mixed

model analysis of variance was used (groups × before/after). Pain in the various body segments was compared among groups using the Mann-Whitney U Test. The Kruskal-Wallis Test was also used where appropriate.

(4) Logistic regression was used to determine the association between LBP and seat pad use. Three models were developed with outcome measures either LBP in the last 7 days, LBP in the last 6 months, or LBP while driving, The first analyses included only group (NSP or SP) as a covariate. Subsequently, other covariates from the background questionnaires were included in a multivariate logistic regression model if group differences on the covariate were $p < 0.05$ in the univariate analyses[96]. The multivariate logistic regression established risk of LBP based on group membership in the presence of multiple covariates.

7. RESULTS. With a few exceptions, the presentation of the results follow the sequence in background and post-project questionnaires. Questions that were asked only on the background questionnaire follow the sequence on that questionnaire.

a. Participants. There were initially 53 Soldiers in the NSP group and 45 Soldiers in the SP group. However, because of logistical difficulties in getting the questionnaire administrators back into the Kuwaiti theater, many of the Soldiers in the NSP group had already departed Kuwait before administration of the post-project questionnaire. The control group was part of a reserve unit and efforts to track them down through e-mail using Army Knowledge On-Line resulted in only one additional follow-up. A few Soldiers in the SP group also left Kuwait before the project team returned. The final sample consisted of 13 in the NSP group and 43 in the SP group. Analysis of group differences on the Background Questionnaire in the larger cohort (53 in NSP group and 45 in SP group) is in Appendix G. The main body of this technical report compares the smaller cohort (n=13 in NSP group, n=43 in SP group), Soldiers who completed both the background questionnaire and post-project questionnaire.

b. Deployment Time in Kuwait. Responses to Question 8 on the background questionnaire indicated that the NSP and SP groups had served similar times in Kuwait, 43±44 versus 49±15 days ($p=0.44$), respectively. Time in Kuwait for the NSP group ranged from 3 to 186 days, and for the SP group the time ranged from 17 to 139 days. The time between the background questionnaire and post-project questionnaire was 201±3 days for the NSP group and 199±6 days for the SP group ($p=0.23$). Responses to Question 27 on the background questionnaire indicated that Soldiers in the NSP group were all National Guardsmen (n=13), while Soldiers in the SP group (n=43) were all active Army.

c. Age and Physical Fitness. Table 6 shows a comparison of the groups on their age and physical fitness. Age and Army Physical Fitness Test (APFT) raw scores were requested only on the background survey. The NSP group was older (by 6.2 years) and took longer to complete the 2-mile run on their last APFT (1.2 minutes longer), indicating that they were less aerobically fit.

Muscular endurance was similar for the two groups based push-up and sit-up performance, although here again the NSP group tended to have slightly lower performance. The NSP and SP groups reported taking their last APFT 101±46 and 93±39 days (about 3 months) prior to the start of the project (p=0.55), respectively.

Table 6. Comparison of Groups on Age and Fitness Measures

| Variable Grouping | Variable | Group | n | Pre-Intervention Comparison | t-test p-value |
|---|---|---|---|---|---|
| Age | Age (yrs) | NSP | 13 | 32.7±8.6 | <0.01 |
| | | SP | 43 | 26.5±5.5 | |
| Physical Fitness | Push-Ups (n) | NSP | 12 | 56±13 | 0.24 |
| | | SP | 41 | 60±10 | |
| | Sit-Ups (n) | NSP | 13 | 61±20 | 0.25 |
| | | SP | 40 | 65±9 | |
| | 2-Mile Run Time (min) | NSP | 11 | 16.5±1.8 | 0.02 |
| | | SP | 38 | 15.3±1.2 | |

Legend: NSP – no seat pad; SP – seat pad

d. Comparison of Group Responses on Background and Post-Project Questionnaires.

(1) Physical Characteristics. Table 7 shows the reported heights and weights of the Soldiers with the calculated body mass index. Self-reported height was similar in both group in the pre-intervention and intervention periods. Self-reported body weight was higher in the post-intervention period in the NSP group (1.7 kg higher), while it was not different in the pre-intervention and post-intervention periods in the SP group. This resulted in a larger pre-intervention versus intervention difference in the BMI of the NSP group (0.6 kg/m$^2$ higher) compared with virtually no difference in the SP group (0.1 kg/m$^2$ higher).

Table 7. Comparison of Groups on Age and Fitness Measures

| Variable | Group | n | Pre-Intervention Period | Intervention Period | Difference (%)[a] | Analysis of Variance p-values | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Period | Group | Period × Group |
| Height (cm) | NSP | 13 | 179.7±6.4 | 178.6±6.3 | -0.6 | 0.16 | 0.95 | 0.93 |
| | SP | 43 | 179.8±7.3 | 178.5±7.2 | -0.7 | | | |
| Weight (kg) | NSP | 13 | 86.2±15.5 | 87.9±14.1 | 2.0 | 0.14 | 0.86 | 0.05 |
| | SP | 42 | 86.3±11.0 | 86.3±10.2 | 0.0 | | | |
| BMI (kg/m$^2$) | NSP | 13 | 26.9±4.5 | 27.5±3.9 | 2.2 | 0.06 | 0.80 | 0.15 |
| | SP | 42 | 26.9±3.6 | 27.0±3.3 | 0.4 | | | |

Legend: NSP – no seat pad; SP – seat pad
Notes:
[a]Calculated as ([Post–Pre]/Pre) × 100%

(2) Physical Activity and Tobacco Use.

(a) Table 8 shows a comparison of the two groups on responses to the questions on physical activity and tobacco use. There were no group differences in the pre-intervention or intervention periods when the groups were asked to compare themselves to their peers on physical activity. On the frequency of exercise or sports over the last 2 months, there were no pre-intervention differences between the groups; however, in the intervention period, the SP group reported more frequent exercise and sports activity compared with the NSP group.

(b) Because of the small number of Soldiers, the tobacco-use questions were combined so that only two groups were compared. These groups were nonsmokers and smokers (for cigarette use) and users and nonusers (for smokeless tobacco). Two levels of tobacco use were defined: (1) those smoking or using smokeless tobacco on any of the 30 days prior to the questionnaire and (2) those smoking or using smokeless tobacco on 20 or more of the 30 days prior to the questionnaire. Group differences in the proportion of smokers and the proportion of smokeless tobacco users were small, although there tended to be proportionally more smokers in the SP group.

(c) In the pre-intervention period, 15.4% (n=2) of the NSP group and 9.3% (n=4) of the SP group reported that they had quit smoking ($p=0.62$). In the intervention period, 15.4% (n=2) of the NSP group and 7.3% (n=3) of the SP group reported that they had quit smoking ($p=0.58$).

(d) Packs of cigarettes smoked in the last 30 days was calculated by multiplying the number of days smoking in the last 30 days (one month) by cigarettes smoked per day and dividing by 20 (the number of cigarettes in a pack). In the pre-intervention period, the NSP group had 10±13 pack-months while the SP group had 14±11 pack-months. In the intervention period, the NSP had 10±13 pack-months and the SP group 13±11 pack-months. When the two groups were compared using a two-way analysis of variance (groups × periods), there was little difference between the groups ($p=0.58$) or periods ($p=0.88$) or in the group × period interaction ($p=0.89$).

Table 8. Comparison of Groups on Physical Activity and Tobacco Use

| Variable Name | Group | Response Category | Pre-Intervention (% in Category {n}) | Intervention (% in Category {n}) | Pre- Intervention Group Comparison p-value[a] | Intervention Group Comparison p-value[a] |
|---|---|---|---|---|---|---|
| Physical Activity Compared to Peers | NSP | Much Less Active | 0.0 {0} | 0.0 {0} | 0.65 | 0.51 |
| | | Less Active | 0.0 {0} | 7.7 {1} | | |
| | | About the Same | 53.8 {7} | 30.8 {4} | | |
| | | More Active | 23.1 {3} | 23.1 {3} | | |
| | | Much More Active | 23.1 {3} | 38.5 {5} | | |
| | SP | Much Less Active | 0.0 {0} | 0.0 {0} | | |
| | | Less Active | 7.0 {3} | 7.0 {3} | | |
| | | About the Same | 41.9 {18} | 44.2 {19} | | |
| | | More Active | 32.6 {14} | 30.2 {13} | | |
| | | Much More Active | 18.6 {8} | 18.6 {8} | | |
| Exercise or Sports Frequency | NSP | ≤1 time/week | 0 {0} | 0 {0} | 0.21 | 0.02 |
| | | 2 times/week | 15.4 {2} | 7.7 {1} | | |
| | | 3 times/week | 7.7 {1} | 23.1 {3} | | |
| | | 4 time/week | 23.1 {3} | 23.1 {3} | | |
| | | 5 times/week | 15.4 {2} | 23.1 {3} | | |
| | | 6 times/week | 30.8 {4} | 15.4 {2} | | |
| | | 7 times/week | 7.7 {1} | 7.7 {1} | | |
| | SP | ≤1 time/week | 2.3 {1} | 0 {0} | | |
| | | 2 times/week | 2.3 {1} | 0 {0} | | |
| | | 3 times/week | 18.6 {8} | 0 {0} | | |
| | | 4 time/week | 20.9 {9} | 20.9{9} | | |
| | | 5 times/week | 27.9 {12} | 32.6 {14} | | |
| | | 6 times/week | 9.3 {4} | 25.6 {11} | | |
| | | 7 times/week | 18.6 {8} | 20.7 {9} | | |
| Smoked One or More Days in Last 30 Days | NSP | Nonsmoker | 61.5 {8} | 69.2 {9} | 0.35 | 0.22 |
| | | Smoker | 38.5 {5} | 30.8 {4} | | |
| | SP | Nonsmoker | 44.2 {19} | 48.8 {21} | | |
| | | Smoker | 55.8 {24} | 51.2 {22} | | |
| Smoked on 20 Days in Last 30 Days | NSP | Nonsmoker | 76.9 {10} | 76.9 {10} | 0.11 | 0.12 |
| | | Smoker | 23.1 {3} | 23.1 {3} | | |
| | SP | Nonsmoker | 48.8 {21} | 53.5 {23} | | |
| | | Smoker | 51.2 {22} | 46.5 {20} | | |
| Used Smokeless Tobacco One or More Days in Last 30 Days | NSP | Nonuser | 76.9 {10} | 84.6 {11} | 0.51 | 0.71 |
| | | User | 23.1 {3} | 15.4 {2} | | |
| | SP | Nonuser | 63.4 {26} | 73.2 {30} | | |
| | | User | 36.6 {15} | 26.8 {11} | | |
| Used Smokeless Tobacco 20 of 30 Days in Last 30 Days | NSP | Nonuser | 84.6 {11} | 84.6 {11} | 0.99 | 0.99 |
| | | User | 15.4 {2} | 15.4 {2} | | |
| | SP | Nonuser | 80.5 {33} | 85.7 {36} | | |
| | | User | 19.5 {8} | 14.3 {6} | | |

Legend: NSP – no seat pad; SP – seat pad
Notes:
[a]From Fisher Exact Test for 2×2 comparisons, or chi-square statistic for other than 2×2 comparisons

(3) Recent Injuries

(a) Table 9 shows group comparisons on the questions dealing with injuries in the last 6 months. Group differences were small in the proportion of Soldiers reporting injuries in either the pre-intervention or the intervention periods. Likewise, there were only small group differences in either the pre-intervention or intervention periods in the proportion of Soldiers reporting injuries by location, type, need for medical care, or having more than one injury. For injury type, overuse injuries included bursitis, tendonitis, and joint pain; traumatic injuries included strains, sprains, lacerations, and fractures.

(b) In the pre-intervention period, NSP and SP groups reported an average±SD of 5±10 days and 13±18 days of limited duty as a result of injuries, respectively ($p=0.42$). Among the four individuals in the NSP group who had injuries, three reported no limited duty days, while one reported 20 days. Among the 14 individuals in the SP group who had injuries, seven reported no limited duty days, while one each reported 7, 14, 18, 21, 30, and 60 limited duty days. During the intervention period, NSP and SP groups reported an average±SD of 33±36 days and 17±31 days, respectively, of limited duty as a result of injuries ($p=0.33$). The five individuals in the NSP group with injuries reported 0, 10, 21, 45, and 90 limited duty days. Among the 15 individuals in the SP group with injuries, nine reported no limited duty days, two reported 90 days, and one each reported 4, 14, 21, 30 limited duty days.

Table 9. Comparison of Groups on Injuries in the Last 6 Months

| Variable Name | Group | Response Category | Pre-Intervention Period (% in Category {n in category}) | Intervention Period (% in Category {n in category}) | Pre-Intervention Group Comparison p-value[a] | Intervention Group Comparison p-value[a] |
|---|---|---|---|---|---|---|
| Any Injury In Last 6 Months | NSP | No | 69.2 {9} | 61.5 {8} | 0.53 | 0.99 |
| | | Yes | 30.8 {4} | 38.5 {5} | | |
| | SP[b] | No | 65.1 {28} | 61.9 {26} | | |
| | | Yes | 34.9 {15} | 38.1 {16} | | |
| Injury Anatomic Location | NSP | No Injury | 69.2 {9} | 61.5 {8} | 0.90 | 0.99 |
| | | Upper Body | 15.4 {2} | 15.4 {2} | | |
| | | Lower Back | 7.7 {1} | 15.4 {2} | | |
| | | Lower Body | 7.7 {1} | 7.7 {1} | | |
| | SP[b] | No Injury | 66.7 {28} | 62.8 {27} | | |
| | | Upper Body | 9.5 {4} | 11.6 {5} | | |
| | | Lower Back | 14.3 {6} | 11.6 {5} | | |
| | | Lower Body | 9.5 {4} | 14.0 {6} | | |
| Injury Type | NSP[b] | No Injury | 75.0 {9} | 61.5 {8} | 0.71 | 0.83 |
| | | Overuse | 8.3 {1} | 15.4 {2} | | |
| | | Traumatic | 8.3 {1} | 15.4 {2} | | |
| | | Other | 8.3 {1} | 7.7 {1} | | |
| | SP[b] | No Injury | 70.0 {28} | 60.5 {26} | | |
| | | Overuse | 10.0 {4} | 7.0 {3} | | |
| | | Traumatic | 17.5 {7} | 20.9 {9} | | |
| | | Other | 2.5 {1} | 11.6 {5} | | |
| Sought Medical Care | NSP | No Injury | 69.2{9} | 75.0 {9} | 0.95 | 0.54 |
| | | No | 7.7 {1} | 8.3 {1} | | |
| | | Yes | 23.1 {3} | 16.7 {2} | | |
| | SP[b] | No Injury | 64.3 {27} | 57.5 {23} | | |
| | | No | 9.5 {4} | 17.5 {7} | | |
| | | Yes | 26.2 {11} | 25.0 {10} | | |
| More than One Injury | NSP[a] | No Injury | 69.2 {9} | 50.0 {6} | 0.71 | 0.19 |
| | | No | 30.8 {4} | 50.0 {6} | | |
| | | Yes | 0.0 {0} | 0.0 {0} | | |
| | SP[b] | No Injury | 62.8 {27} | 61.9 {26} | | |
| | | No | 32.6 {14} | 26.2 {11} | | |
| | | Yes | 4.7 {2} | 11.9 {5} | | |

Legend: NSP – no seat pad; SP – seat pad

Notes:

[a]From Fisher Exact Test for 2X2 comparisons, or chi-square statistic for other than 2X2 comparisons

[b]Some responses were missing and not considered in the analysis

(c) Table 10 shows the activities associated with injury in the pre-intervention and intervention periods. Sports and physical training were the activities associated with the largest proportion of injuries (35% for both groups in the pre-intervention and intervention periods combined). Driving-related events were associated with 13% of the activities associated with injury in both groups and both periods combined.

Table 10. Activities Associated With Injury in the Last Six Months

| Activity | No Seat Pad Group | | | | Seat Pad Group | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-intervention | | Intervention | | Pre-intervention | | Intervention | |
| | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) |
| Physical Training/Sports | 1 | 25.0 | 1 | 20.0 | 3 | 20.0 | 2 | 13.3 |
| Sports | 0 | 0.0 | 0 | 0.0 | 5 | 33.3 | 2 | 13.3 |
| Field Activities | 0 | 0.0 | 0 | 0.0 | 4 | 26.7 | 0 | 0.0 |
| Garrison Activities | 0 | 0.0 | 1 | 20.0 | 1 | 6.7 | 0 | 0.0 |
| Chronic Conditions | 0 | 0.0 | 0 | 0.0 | 1 | 6.7 | 3 | 20.0 |
| Driving | 1 | 25.0 | 1 | 20.0 | 1 | 6.7 | 2 | 13.3 |
| Road Marching | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 6.7 |
| Combatives | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 6.7 |
| Unknown | 1 | 25.0 | 2 | 40.0 | 0 | 0.0 | 4 | 26.7 |
| Missing (No Response) | 1 | 25.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

(4) Low Back Pain in Last 7 Days

(a) Table 11 shows group comparisons on questions relating LBP in the last 7 days. Because of the small number of subjects, the first question on LBP ("Did you have aches, pain, discomfort, or other symptoms with your low back?"), which allowed answers of "never," "seldom," or "often," was converted to two categories ("no" or "yes"). The "no" category was the "never" response, while the "yes" combined Soldiers responding in the "seldom" or "often" categories.

(b) As shown in Table 11 and Figure 8, the proportion of SP Soldiers reporting LBP in the last 7 days declined slightly in the intervention period. In contrast, the proportion of NSP Soldiers reporting LBP increased in the intervention period.

(c) Table 11 shows that there were only small group differences in the proportion of Soldiers reporting on the frequency or location of LBP in the last 7 days in either period. There were also small group differences in the proportion of Soldiers reporting that movements caused their LBP in the last 7 days in either period. In the intervention period, a larger proportion of individuals in the SP group noted that there were movements that aggravated their LBP in the last 7 days.

Table 11. Comparison of Groups on Low Back Pain in the Last 7 Days

| Variable Name | Group | Category of Variable | Pre-Intervention (% in Category {n in category}) | Intervention (% in Category {n in category}) | Pre-Intervention Group Comparison p-value[a] | Intervention Group Comparison p-value[a] |
|---|---|---|---|---|---|---|
| LBP In Last 7 Days | NSP | No | 41.7 {5} | 15.4 {2} | 0.11 | 0.30 |
| | | Yes | 58.3 {7} | 84.6 {11} | | |
| | SP | No | 16.3{7} | 27.9 {12} | | |
| | | Yes | 83.7 {36} | 72.1 {31} | | |
| Frequency of LBP in Last 7 Days | NSP | Once | 0.0 {0} | 0.0 {0} | 0.51 | 0.32 |
| | | Episodic | 85.7 {6} | 100.0 {10} | | |
| | | Constant | 14.3 {1} | 0.0 {0} | | |
| | SP | Once | 13.9 {5} | 3.2 {1} | | |
| | | Episodic | 66.7 {24} | 80.6 {25} | | |
| | | Constant | 19.4 {7} | 16.1 {5} | | |
| Location of LBP in Last 7 Days | NSP | Low Back Only | 71.4 {5} | 40.0 {4} | 0.49 | 0.34 |
| | | Low Back/Buttocks | 14.3 {1} | 20.0 {2} | | |
| | | Low Back/Buttocks/Legs | 14.3 {1} | 20.0 {2} | | |
| | | Low Back/Other | 0.0 {0} | 20.0 {2} | | |
| | SP | Low Back Only | 44.4 {16} | 62.1 {18} | | |
| | | Low Back/Buttocks | 13.9 {5} | 17.2 {5} | | |
| | | Low Back/Buttocks/Legs | 22.2 {8} | 3.4 {1} | | |
| | | Low Back/Other | 19.4 {7} | 17.2 {5} | | |
| Movement Caused LBP in Last 7 Days | NSP | No | 71.4 {5} | 54.5 {6} | 0.70 | 0.25 |
| | | Yes | 28.6 {2} | 45.5 {5} | | |
| | SP | No | 61.1 {22} | 76.7 {23} | | |
| | | Yes | 38.6 {14} | 23.3 {7} | | |
| Movement Aggravated LBP in Last 7 Days | NSP | No | 42.9 {3} | 27.3 {3} | 0.70 | 0.03 |
| | | Yes | 57.1 {4} | 72.7 {8} | | |
| | SP | No | 52.9 {18} | 65.6 {21} | | |
| | | Yes | 47.1 {16} | 34.4 {11} | | |

Legend: LBP=Low back pain; NSP – no seat pad; SP – seat pad

Notes:

[a]From Fisher Exact Test for 2X2 comparisons, or chi-square statistic for other than 2X2 comparisons

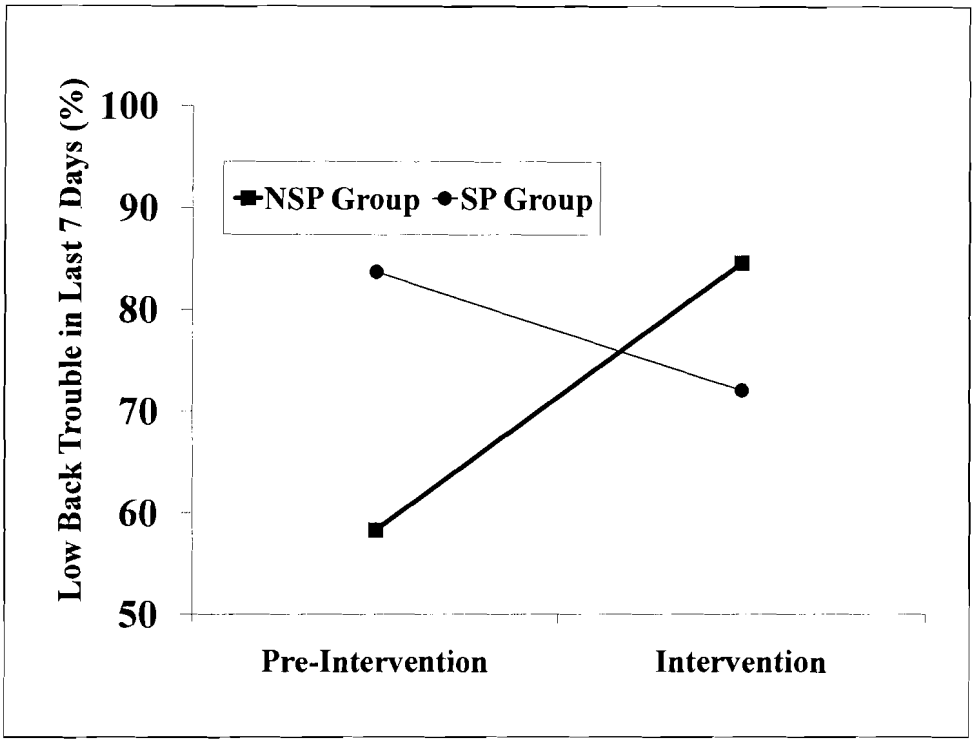



Figure 8. Group Differences in Proportion of Soldiers Reporting Low Back Pain in the Last 7 Days in Pre-Intervention and Intervention Periods

(d) Table 12 shows movements that the Soldiers reported caused their LBP in the last 7 days; Table 13 shows movements that the Soldiers reported aggravated their LBP in the last 7 days. Bending and/or twisting accounted for 43% of the reported movements causing back trouble and 33% of movements reported as aggravating back trouble. Vehicle operations were reported to account for 25% of the movements causing back trouble and 15% of movements aggravating back trouble. Physical training accounted for 11% of the reported movements causing back trouble and 18% of movements reported to have aggravated back trouble.

Table 12. Movements Soldiers Reported Causing Low Back Pain in Last 7 Days

| Activity | No Seat Pad Group | | | | Seat Pad Group | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-Intervention | | Intervention | | Pre-Intervention | | Intervention | |
| | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) |
| Vehicle Operations | 0 | 0.0 | 2 | 40.0 | 3 | 21.4 | 2 | 28.6 |
| Physical Training | 0 | 0.0 | 0 | 0.0 | 2 | 14.3 | 1 | 14.3 |
| Bending/Twisting | 1 | 50.0 | 2 | 40.0 | 6 | 42.9 | 3 | 42.9 |
| Various or Sudden Movements | 1 | 50.0 | 0 | 0.0 | 1 | 7.1 | 0 | 0.0 |
| Lifting/Pulling | 0 | 0.0 | 1 | 20.0 | 2 | 14.3 | 0 | 0.0 |
| Any Movement | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 14.3 |
| Sitting/Lying Down | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

Table 13. Movements Soldiers Reported Aggravating Low Back Pain in Last 7 Days

| Activity | No Seat Pad Group | | | | Seat Pad Group | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-Intervention | | Intervention | | Pre-Intervention | | Intervention | |
| | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) |
| Vehicle Operations | 0 | 0.0 | 3 | 37.5 | 2 | 12.5 | 1 | 9.1 |
| Physical Training | 0 | 0.0 | 1 | 12.5 | 5 | 31.3 | 1 | 9.1 |
| Bending/Twisting | 3 | 75.0 | 4 | 50.0 | 2 | 12.5 | 4 | 36.4 |
| Lifting/Pulling | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Any Movement | 0 | 0.0 | 0 | 0.0 | 1 | 6.3 | 1 | 9.1 |
| Sitting/Lying Down | 0 | 0.0 | 0 | 0.0 | 4 | 25.0 | 2 | 18.2 |
| Standing | 1 | 25.0 | 0 | 0.0 | 1 | 6.3 | 1 | 9.1 |
| No Response | 0 | 0.0 | 0 | 0.0 | 1 | 6.3 | 1 | 9.1 |

(e) For Soldiers reporting LBP, Table 14 shows group comparisons for the continuous variables on the questions related to episodes, duration, and severity of LBP in the last 7 days. Although not statistically significant, the SP group reported a decline in the intervention period for the number of LBP episodes, LBP duration, and the severity of LBP during driving, lifting, walking, standing, sitting, and sleeping. In contrast, the NSP group reported an increase in all these measures with the exception of LBP while driving. For LBP while driving, both groups reported lower severity values in the intervention period. The severity of LBP while sleeping was higher for the SP group than for the NSP group.

Table 14. Comparison of Groups on Episodes, Duration and Severity of Low Back Pain in the Last 7 Days

| Variable | Group | n | Pre-Intervention Mean±SD | Intervention Mean±SD | Difference (%)[a] | Analysis of Variance p-values[b] | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Period | Group | Period × Group |
| Episodes of LBP (n) | NSP | 6 | 2.2±1.6 | 2.7±2.4 | 22.7 | 0.70 | 0.36 | 0.25 |
| | SP | 29 | 3.8±3.1 | 2.8±2.3 | -26.3 | | | |
| Duration of LBP (days) | NSP | 5 | 1.4±0.5 | 2.0±2.3 | 42.9 | 0.71 | 0.12 | 0.21 |
| | SP | 28 | 3.8±2.6 | 2.8±2.4 | -26.3 | | | |
| Severity LBP Driving | NSP | 6 | 5.3±2.9 | 3.5±3.9 | -34.0 | 0.01 | 0.43 | 0.80 |
| | SP | 31 | 4.4±2.2 | 2.9±2.4 | -34.1 | | | |
| Severity LBP Lifting | NSP | 6 | 2.3±1.6 | 2.8±2.6 | 21.7 | 0.99 | 0.45 | 0.40 |
| | SP | 31 | 3.6±2.6 | 3.1±2.7d | -13.9 | | | |
| Severity LBP Walking | NSP | 6 | 1.7±1.5 | 2.2±3.1 | 70.6 | 0.87 | 0.63 | 0.45 |
| | SP | 31 | 1.7±1.9 | 1.4±1.8 | -17.6 | | | |
| Severity LBP Standing | NSP | 6 | 3.8±2.7 | 3.8±4.0 | 0.0 | 0.41 | 0.52 | 0.41 |
| | SP | 31 | 3.5±3.0 | 2.6±2.7 | -25.7 | | | |
| Severity LBP Sitting | NSP | 6 | 2.5±2.2 | 2.0±2.3 | 20.0 | 0.16 | 0.27 | 0.53 |
| | SP | 31 | 3.9±2.7 | 2.6±2.2 | -43.6 | | | |
| Severity LBP Sleeping | NSP | 6 | 1.2±2.4 | 1.7±2.0 | 41.7 | 0.59 | 0.01 | 0.23 |
| | SP | 31 | 4.4±2.7 | 3.1±2.6 | -29.5 | | | |

Legend: LBP=Low back pain; NSP – no seat pad; SP – seat pad
Notes:
[a]Calculated as post-pre/pre × 100%
[b]Two-way mixed model analysis of variance with repeated measures

(5) Low Back Pain in Last 6 Months

(a) Table 15 shows group comparisons on questions about LBP in the last 6 months. Because of the small number of subjects, the first question on LBP ("Did you have aches, pain, discomfort, or other symptoms with your low back?") was converted to two categories ("no" or "yes"). The "no" category was the former "never," while the "yes" category combined Soldiers responding "seldom" or "often."

(b) Table 15 shows, and Figure 9 graphically depicts, that the proportion of SP Soldiers experiencing LBP was the same in the pre-intervention and intervention periods. In contrast, the proportion of NSP Soldiers with LBP increased in the intervention period.

(c) There were only very small group differences in the proportion of Soldiers reporting on the frequency, location, or movements that caused LBP in the last 6 months. In the

intervention period, a larger proportion of individuals in the SP group reported that there were movements that aggravated their LBP in the last 6 months.

Table 15. Comparison of Groups on Low Back Pain in the Last 6 Months

| Variable | Group | Category of Variable | Pre-Intervention (% in Category {n in category}) | Intervention (% in Category {n in category}) | Pre-Intervention Group Comparison p-value[a] | Intervention Group Comparison p-value[a] |
|---|---|---|---|---|---|---|
| LBP in Last 6 Months | NSP | No | 33.3 {4} | 15.4 {2} | 0.23 | 0.99 |
| | | Yes | 66.7 {8} | 84.6 {11} | | |
| | SP | No | 16.3 {7} | 16.3 {7} | | |
| | | Yes | 83.7 {36} | 83.7 {36} | | |
| Frequency of LBP in Last 6 Months | NSP | Once | 0.0 {0} | 0.0 {0} | 0.32 | 0.29 |
| | | Episodic | 100.0 {7} | 100.0 {10} | | |
| | | Constant | 0.0 {0} | 0.0 {0} | | |
| | SP | Once | 8.6 {3} | 2.9 {1} | | |
| | | Episodic | 74.3 {26} | 79.4 {27} | | |
| | | Constant | 17.1 {6} | 17.6 {6} | | |
| Location of LBP in Last 6 Months | NSP | Low Back Only | 75.0 {6} | 40.0 {4} | 0.39 | 0.62 |
| | | Low Back/Buttocks | 12.5 {1} | 20.0 {2} | | |
| | | Low Back/Buttocks/Legs | 12.5 {1} | 20.0 {2} | | |
| | | Low Back/Other | 0.0 {1} | 20.0 {2} | | |
| | SP | Low Back Only | 44.1 {15} | 61.8 {21} | | |
| | | Low Back/Buttocks | 14.7 {5} | 14.7 {5} | | |
| | | Low Back/Buttocks/Legs | 23.5 {8} | 8.8 {3} | | |
| | | Low Back/Other | 17.6 {6} | 14.7 {5} | | |
| Movement Caused LBP in Last 6 Months | NSP | No | 62.5 {5} | 54.5 {6} | 0.99 | 0.13 |
| | | Yes | 37.5 {3} | 45.5 {5} | | |
| | SP | No | 64.7 {22} | 79.4 {27} | | |
| | | Yes | 35.3 {12} | 20.6 {7} | | |
| Movement Aggravated LBP in Last 6 Months | NSP | No | 37.5 {3} | 30.0 {3} | 0.24 | 0.03 |
| | | Yes | 62.5 {5} | 70.0 {7} | | |
| | SP | No | 64.5 {20} | 69.4 {25} | | |
| | | Yes | 35.5 {11} | 30.6 {11} | | |

Legend: LBP=Low back pain; NSP – no seat pad; SP – seat pad

Notes:

[a] From Fisher Exact Test (for 2X2 comparisons) or chi-square statistic (for other than 2X2 comparisons).

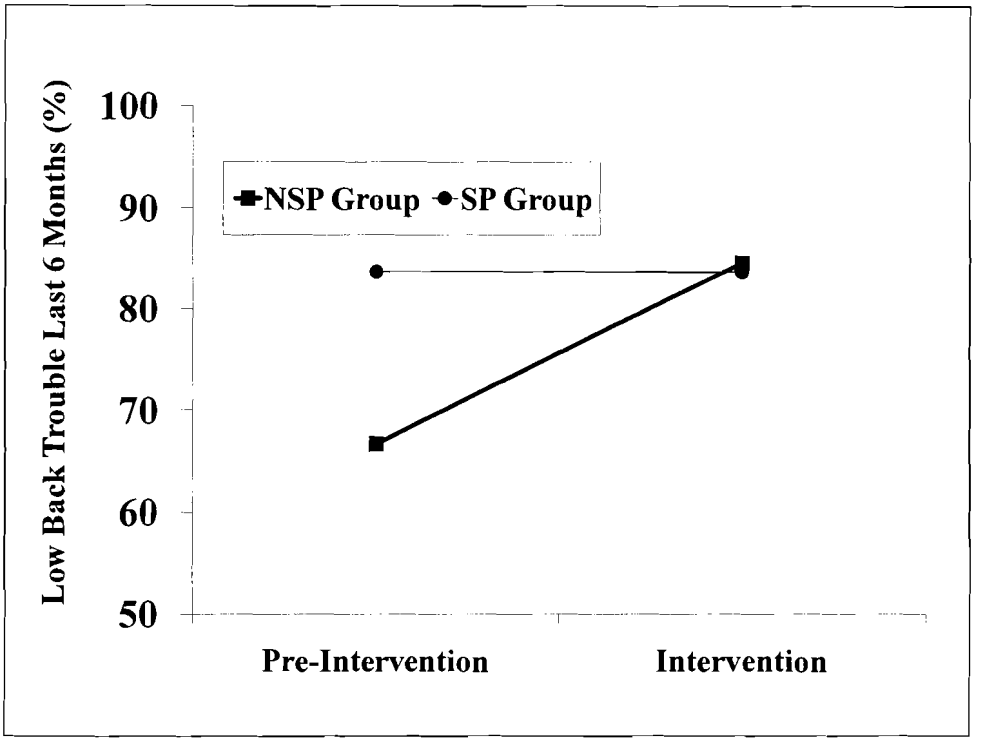



Figure 9. Group Differences in Proportion of Soldiers Reporting Low Back Pain in the Last 6 Months in Pre-Intervention and Intervention Period

(d) Tables 17 and 18 show activities that Soldiers reported had caused or aggravated their LBP in the last 6 months. The predominant activity was bending and/or twisting, which accounted for 44% of the movements reported to cause back trouble and 35% of movements reported to aggravate back trouble. Vehicle operations accounted for 11% of the movements reported to cause back trouble and 21% of those reported to aggravate back trouble. Physical training accounted for 15% of the movements reported as causing back trouble and 15% of those aggravating back trouble.

Table 17. Movements Soldiers Reported Causing Low Back Pain in Last 6 Months

| Activity | No Seat Pad Group | | | | Seat Pad Group | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-intervention | | Intervention | | Pre-intervention | | Intervention | |
| | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) |
| Vehicle Operations | 0 | 0.0 | 2 | 40.0 | 0 | 0.0 | 1 | 14.3 |
| Physical Training | 0 | 0.0 | 1 | 20.0 | 3 | 25.0 | 0 | 0.0 |
| Bending/Twisting | 2 | 66.7 | 1 | 20.0 | 5 | 41.7 | 4 | 57.1 |
| Lifting/Pulling | 0 | 0.0 | 1 | 20.0 | 2 | 16.7 | 1 | 14.3 |
| Any Movement | 1 | 33.3 | 0 | 0.0 | 1 | 8.3 | 0 | 0.0 |
| Sitting/Lying Down | 0 | 0.0 | 0 | 0.0 | 1 | 8.3 | 0 | 0.0 |
| Not Sure | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 14.3 |

Table 18. Movements Soldiers Reported Aggravating Low Back Pain in Last 6 Months

| Activity | No Seat Pad Group | | | | Seat Pad Group | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-intervention | | Intervention | | Pre-intervention | | Intervention | |
| | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) |
| Vehicle Operations | 0 | 0.0 | 3 | 42.8 | 2 | 18.2 | 2 | 18.2 |
| Physical Training | 0 | 0.0 | 1 | 14.3 | 3 | 27.3 | 1 | 9.1 |
| Bending/Twisting | 3 | 75.0 | 3 | 42.8 | 2 | 18.2 | 4 | 36.4 |
| Any Movement | 1 | 0.0 | 0 | 0.0 | 1 | 9.1 | 0 | 0.0 |
| Sitting/Lying Down | 0 | 0.0 | 0 | 0.0 | 2 | 18.2 | 3 | 27.3 |
| Standing | 1 | 25.0 | 0 | 0.0 | 1 | 9.1 | 1 | 9.1 |

(e) For Soldiers reporting LBP, Table 19 shows group comparisons on the episodes, duration, and severity of LBP in the last 6 months. For the episodes and duration of LBP, the SP group's data was highly skewed because two individuals in the SP group reported 180 episodes and 180 days of LBP. In the NSP group, the maximum number of episodes was 30 and the maximum number of days was 30. Nonetheless, the only statistically significant difference between the groups was for pain severity while sleeping, where the SP group reported higher values.

Table 19. Comparison of Groups on Episodes, Duration and Severity of Low Back Pain in the Last 6 Months

| Variable | Group | n | Pre-Intervention Mean±SD | Intervention Mean±SD | Difference[a] (%) | Analysis of Variance p-values[b] | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Period | Group | Period × Group |
| Episodes of LBP (n) | NSP | 6 | 8.0±6.9 | 9.8±6.2 | 22.5 | 0.80 | 0.38 | 0.93 |
| | SP | 24 | 22.8±49.0 | 26.5±50.9 | 16.2 | | | |
| Duration of LBP (days) | NSP | 5 | 4.8±4.0 | 9.3±10.3 | 93.8 | 0.92 | 0.27 | 0.71 |
| | SP | 27 | 33.3±62.8 | 25.3±50.5 | -24.0 | | | |
| Severity LBP Driving | NSP | 7 | 4.9±3.1 | 4.7±3.4 | -4.1 | 0.45 | 0.36 | 0.63 |
| | SP | 35 | 4.3±2.3 | 3.7±2.1 | -14.0 | | | |
| Severity LBP Lifting | NSP | 7 | 2.9±2.5 | 2.9±2.6 | 0.0 | 0.65 | 0.51 | 0.65 |
| | SP | 35 | 3.7±2.5 | 3.2±2.4 | -13.5 | | | |
| Severity LBP Walking | NSP | 7 | 2.4±2.9 | 2.3±1.8 | -4.2 | 0.88 | 0.27 | 0.92 |
| | SP | 35 | 1.6±1.8 | 1.6±1.8 | 0.0 | | | |
| Severity LBP Standing | NSP | 7 | 4.3±2.4 | 3.3±3.9 | -23.3 | 0.13 | 0.57 | 0.70 |
| | SP | 35 | 3.5±3.0 | 2.9±2.7 | -17.1 | | | |
| Severity LBP Sitting | NSP | 6 | 2.7±2.1 | 2.0±2.3 | -25.9 | 0.26 | 0.21 | 0.86 |
| | SP | 35 | 3.9±2.7 | 2.9±2.4 | -25.6 | | | |
| Severity LBP Sleeping | NSP | 7 | 1.9±2.5 | 1.9±2.1 | 0.0 | 0.45 | 0.02 | 0.45 |
| | SP | 35 | 4.3±2.5 | 3.3±2.7 | -23.3 | | | |

Legend: LBP=Low back pain; NSP – no seat pad; SP – seat pad
Notes:
[a]Calculated as Post-Pre/Pre X 100%
[b]Two-way mixed model analysis of variance with repeated measures

(f) In response to Question 21, on the Background Questionnaire, 75% and 86% of the NSP and SP groups, respectively, reported that they had had LBP at some point in their lives (p=0.39).

(6) Work History

(a) Work history questions were only asked on the Background questionnaire, so comparisons between groups were made only for the pre-intervention period. Table 20 shows the previous occupations reported by the Soldiers on the Background Questionnaire. Many of those jobs had been in maintenance and construction occupations (26% of the NSP group, 28% of the SP group). Table 21 shows that, on average, the Soldiers had worked for 2 to 6 years in these jobs.

Table 20. Previous Occupations Reported by Soldiers on Background Questionnaire (Question 22)

| Occupational Group | Previous Occupation 1 | | | | Previous Occupation 2 | | | | Previous Occupation 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | |
| | n | % | n | % | n | % | n | % | n | % | n | % |
| Maintenance/Construction | 4 | 30.8 | 16 | 38.1 | 2 | 18.2 | 1 | 5.6 | 1 | 33.3 | 2 | 22.2 |
| Student | 1 | 7.7 | 7 | 16.7 | 0 | 0.0 | 1 | 5.6 | 0 | 0.0 | 0 | 0.0 |
| Retail | 1 | 7.7 | 5 | 11.9 | 2 | 18.2 | 4 | 22.2 | 0 | 0.0 | 2 | 22.2 |
| Professional | 2 | 15.4 | 2 | 4.8 | 2 | 18.2 | 3 | 16.7 | 0 | 0.0 | 2 | 22.2 |
| Factory/Warehouse | 2 | 15.4 | 4 | 9.5 | 1 | 9.1 | 1 | 5.6 | 0 | 0.0 | 0 | 0.0 |
| Driving | 1 | 7.7 | 3 | 7.1 | 1 | 9.1 | 0 | 0.0 | 2 | 66.7 | 0 | 0.0 |
| Fire/Police | 1 | 7.7 | 1 | 2.4 | 0 | 0.0 | 3 | 16.7 | 0 | 0.0 | 1 | 11.1 |
| Medical | 0 | 0.0 | 2 | 4.8 | 1 | 9.1 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Military | 1 | 7.7 | 1 | 2.4 | 1 | 9.1 | 1 | 5.6 | 0 | 0.0 | 0 | 0.0 |
| Mechanic | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 2 | 11.1 | 0 | 0.0 | 0 | 0.0 |
| Farming | 0 | 0.0 | 0 | 0.0 | 1 | 9.1 | 2 | 11.1 | 0 | 0.0 | 1 | 11.1 |
| Landscaping | 0 | 0.0 | 1 | 2.4 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 11.1 |
| Railroad | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

Table 21. Comparison of Groups on Time in Previous Occupations Reported on Background Questionnaire (Question 22)

| Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|
| | n | Mean±SD | n | Mean±SD | |
| Years in Occupation 1 | 13 | 5.7±3.7 | 42 | 4.1±3.7 | 0.18 |
| Years in Occupation 2 | 11 | 5.2±5.5 | 18 | 3.4±3.3 | 0.28 |
| Years in Occupation 3 | 3 | 3.7±3.6 | 9 | 2.2±2.4 | 0.22 |

Notes:
[a]From independent sample t-test

(b) To obtain time in service, the date the Soldier reported completing BCT was backdated by 2 months to account for time in BCT. Table 22 shows that the NSP group had more time in service and time in their military occupational specialty (MOS) than the SP group did.

Table 22. Comparison of Groups on Time in Service and Time in MOS Reported on Background Survey (Questions 23 & 25)

| Question #. Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|
| | n | Mean±SD | n | Mean±SD | |
| Q23. Time in Service (years)[b] | 13 | 11.3±9.0 | 41 | 5.5±5.8 | <0.01 |
| Q25. Time in MOS (years) | 13 | 5.6±5.5 | 43 | 3.9±3.5 | 0.06 |

Notes:
[a]From independent sample t-test
[b]The date the Soldier reported completed BCT was backdated by 2 months

(c) Table 23 shows the Soldiers' MOSs. In the SP group, all but one Solider was a motor transport operator or officer. The NSP group had a wider variety of MOSs, with 46% working outside their MOS (inside versus outside MOS: $p<0.01$).

Table 23. Comparison of Groups on Military Occupational Specialties Reported on Background Questionnaire (Question 26)

| MOS (MOS Number) | No Seat Pad Group | | Seat Pad Group | |
|---|---|---|---|---|
| | n | % | n | % |
| Motor Transport Operator (88M) | 7 | 53.8 | 41 | 95.3 |
| Motor Transport Officer (88A) | 0 | 0.0 | 1 | 2.3 |
| Combat Engineer (21B) | 3 | 23.1 | 0 | 0.0 |
| Infantryman (11B) | 1 | 7.7 | 0 | 0.0 |
| Field Artillery Data Systems Operator (13D) | 1 | 7.7 | 0 | 0.0 |
| Food Service Specialist (92G) | 1 | 7.7 | 0 | 0.0 |
| Information Systems Operator (74D) | 0 | 0.0 | 1 | 2.3 |

Legend: MOS – military occupational specialty

(d) Table 24 shows the occupations outside the Army for the National Guard Soldiers. Table 24 contains Soldiers from the NSP group only, since all SP Soldiers were active Army. NSP Soldiers were involved in professional work, which included clergy and information technology (2 Soldiers in the latter group). Three Soldiers reported military occupations including armaments, honor guard, and retention/recruiting.

Table 24. Occupations Outside the Army Reported by Army Reservists and National Guardsmen (Question 27)

| Occupation | n | % |
|---|---|---|
| Professional | 3 | 23.1 |
| Military | 3 | 23.1 |
| No Occupation | 1 | 7.7 |
| Construction | 1 | 7.7 |
| Fire/Police | 1 | 7.7 |
| Driving | 1 | 7.7 |
| Missing (no Response) | 3 | 23.1 |

(e) Table 25 shows the vehicles that the Soldiers reported driving for work prior to deployment. Soldiers in the NSP group were proportionally more likely to have reported driving small trucks and passenger vehicles. Soldiers in the SP group were proportionally more likely to have reported driving palletized loading systems.

Table 25. Previous Vehicles Soldiers Reported Driving for Work on the Background Survey[a] (Question 28)

| Vehicle | Vehicle 1 | | | | Vehicle 2 | | | | Vehicle 3 | | | | All Vehicles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | |
| | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| Small Truck | 2 | 15.4 | 1 | 2.3 | 2 | 22.2 | 0 | 0.0 | 1 | 16.7 | 0 | 0.0 | 5 | 17.9 | 1 | 1.4 |
| Large Truck | 0 | 0.0 | 1 | 2.3 | 0 | 0.0 | 0 | 0.0 | 1 | 16.7 | 5 | 41.7 | 1 | 3.6 | 6 | 8.1 |
| Passenger Vehicle | 6 | 46.2 | 2 | 4.7 | 2 | 22.2 | 2 | 10.5 | 0 | 0.0 | 2 | 16.6 | 8 | 28.6 | 6 | 8.1 |
| HMMWV | 1 | 7.7 | 8 | 18.6 | 3 | 33.3 | 7 | 36.8 | 2 | 33.0 | 1 | 8.3 | 6 | 21.4 | 16 | 21.6 |
| HET | 2 | 15.4 | 6 | 14.0 | 0 | 0.0 | 0 | 0.0 | 1 | 16.7 | 0 | 0.0 | 3 | 10.7 | 6 | 8.1 |
| HEMMT | 0 | 0.0 | 2 | 4.7 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 2 | 2.7 |
| PLS | 1 | 7.7 | 10 | 23.3 | 1 | 11.1 | 8 | 42.1 | 0 | 0.0 | 0 | 0.0 | 2 | 7.1 | 18 | 24.3 |
| Tractor | 0 | 0.0 | 4 | 9.3 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 8.3 | 0 | 0.0 | 5 | 6.8 |
| Forklift | 1 | 7.7 | 0 | 0.0 | 0 | 00 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 3.6 | 0 | 0.0 |
| Tank | 0 | 0.0 | 1 | 2.3 | 1 | 11.1 | 1 | 5.3 | 0 | 0.0 | 1 | 8.3 | 1 | 3.6 | 3 | 4.1 |
| LMTV | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 5.3 | 1 | 16.7 | 2 | 16.6 | 1 | 3.6 | 3 | 4.1 |
| No Vehicle Reported | 0 | 0.0 | 8 | 18.6 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 8 | 10.8 |

Legend: HMMWV-High Mobility Multipurpose Wheeled Vehicle; HET – Heavy Equipment Transporter; HEMMT- Heavy Expanded Mobility Tactical Truck; PLS – Palletized Loading System; LMTV – Light Medium Tactical Vehicle
Notes:
[a]Denominators used to calculate proportions (%) were based on the number of vehicles reported.

(f) Table 26 compares the groups on driving duration, frequency, distance, and seat comfort for the vehicles the Soldiers drove for work prior to deployment. The SP group tended to report longer driving durations (hours/run) and lower seat comfort on Vehicle 1.

Table 26. Group Comparisons on Driving Duration, Frequency, Distance and Seat Comfort While Driving in Vehicles for Previous Work (Question 28)

| Vehicle | Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|---|
| | | n | Mean±SD | n | Mean±SD | |
| Vehicle 1 | Duration (Hours/Run) | 12 | 4.7±3.2 | 24 | 9.3±11.8 | 0.20 |
| | Frequency (Runs/Month) | 12 | 15.2±13.2 | 22 | 17.4±37.3 | 0.84 |
| | Distance (Miles/Run) | 9 | 91±157 | 21 | 119±69 | 0.50 |
| | Comfort Rating[b] | 13 | 3.3±1.3 | 34 | 2.5±1.4 | 0.06 |
| Vehicle 2 | Duration (Hours/Run) | 8 | 5.3±4.0 | 14 | 11.7±25.5 | 0.50 |
| | Frequency (Runs/Month) | 9 | 12.7±13.6 | 13 | 22.7±48.1 | 0.55 |
| | Distance (Miles/Run) | 8 | 303±687 | 13 | 288±357 | 0.95 |
| | Comfort Rating[b] | 9 | 2.8±1.3 | 20 | 2.5±1.1 | 0.58 |
| Vehicle 3 | Duration (Hours/Run) | 6 | 5.1±4.5 | 7 | 9.7±5.7 | 0.14 |
| | Frequency (Runs/Month) | 5 | 9.6±11.9 | 5 | 8.0±9.8 | 0.82 |
| | Distance (Miles/Run) | 5 | 90±81 | 6 | 330±436 | 0.26 |
| | Comfort Rating[b] | 6 | 2.2±1.0 | 11 | 2.9±1.3 | 0.23 |

Notes:
[a]Duration, frequency, and distance were analyzed with independent sample t-tests; seat comfort was analyzed with Mann-Whitney U test
[b]Comfort rating scale is 1 to 5 (low to high comfort)

(7) Deployment History. Sixty-nine percent (n=9) of the NSP group and 49% (n=21) of the SP group had been deployed previously (p=0.10). Table 27 shows the locations of the last three reported deployments. No one reported four prior deployments. Prior deployments to Iraq were reported by 38% and 39% of the NSP and SP groups, respectively. Prior deployments to Kuwait were reported by 15% and 28% of the NSP and SP groups, respectively.

Table 27. Previous Deployment Locations (Question 34)

| Location | Deployment 1 | | | | Deployment 2 | | | | Deployment 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | |
| | n | % | n | % | n | % | n | % | n | % | n | % |
| Iraq | 5 | 55.6 | 11 | 52.4 | 0 | 0.0 | 6 | 46.2 | 0 | 0.0 | 0 | 0.0 |
| Kuwait | 1 | 11.1 | 5 | 23.8 | 1 | 50.0 | 5 | 38.5 | 0 | 0.0 | 2 | 100.0 |
| Afghanistan | 0 | 0.0 | 4 | 19.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Germany | 1 | 11.1 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Korea | 1 | 11.1 | 1 | 4.8 | 0 | 0.0 | 1 | 7.7 | 0 | 0.0 | 0 | 0.0 |
| Other | 1 | 11.1 | 0 | 0.0 | 1 | 50.0 | 1 | 7.7 | 0 | 0.0 | 0 | 0.0 |
| Missing | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

(8) Current Activities.

(a) One question on both the background and post-project surveys related to the vehicles currently being driven. As shown in Table 28, in the pre-intervention period, all Soldiers who responded reported using the HMMWV as one of their vehicles in the pre-intervention period. Other vehicles included a palletized loading system, bulldozer, earth scraper, and grader. Only HMMWVs and Mine-Resistant Ambush Protected (MRAP) vehicles were reported as being driven during the intervention period.

Table 28. Vehicles Driven in Current Deployment

| Period | Vehicle | Vehicle 1 | | Vehicle 2 | | Vehicle 3 | |
|---|---|---|---|---|---|---|---|
| | | No Seat Pad (n) | Seat Pad (n) | No Seat Pad (n) | Seat Pad (n) | No Seat Pad (n) | Seat Pad (n) |
| Pre-Intervention | HMMWV[a] | 13 | 42 | 0 | 1 | 0 | 0 |
| | PLS | 0 | 0 | 0 | 1 | 0 | 0 |
| | Bulldozer | 0 | 1 | 0 | 0 | 0 | 0 |
| | Earth Scraper | 0 | 0 | 0 | 1 | 0 | 0 |
| | Grader | 0 | 0 | 0 | 0 | 0 | 1 |
| Intervention | HMMWV | 13 | 40 | 0 | 0 | 0 | 0 |
| | MRAP | 0 | 2 | 3 | 6 | 0 | 0 |

Legend: HMMWV-High Mobility Multipurpose Wheeled Vehicle; PLS – Palletized Loading System; [c]MRAP=Mine Resistant Ambush Protected

(b) Table 29 shows a comparison of the groups on previous experience with road vibration, lifting, pushing/pulling, and seat cushion use. A larger proportion of the SP group reported experience with road vibration. Lifting during work and pushing/pulling during work

were also more often reported for the SP group, although the differences with the NSP group were small. More Soldiers in the NSP group reported using seat cushions previously.

Table 29. Comparison of Groups on Prior Experience with Road Vibration, Lifting, Pushing/Pulling and Seat Cushion Use Prior to Deployment

| Question #. Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|
| | n | Proportion Yes (%) | n | Proportion Yes (%) | |
| Q29. Experience Road Vibration During Work | 12 | 15.4 | 42 | 47.5 | 0.04 |
| Q30. Require Lifting with Hands During Work | 13 | 84.6 | 43 | 93.0 | 0.35 |
| Q31. Require Push/Pull During Work | 13 | 53.8 | 42 | 59.5 | 0.72 |
| Q32. Previously Use Seat Pads | 13 | 30.8 | 42 | 2.4 | <0.01 |

Notes:
[a]From chi-square test

(c) Table 30 shows group and period comparisons on vehicle driving duration, frequency, distance, and seat comfort. The SP group reported longer driving duration, frequency, and distance, although the differences were not statistically significant. There was a trend for the duration of the runs to increase during the intervention period, especially in the NSP group. Both groups rated the seat comfort as relatively low (almost exclusively HMMWVs).

Table 30. Group Comparisons on Driving Duration, Frequency, Distance and Seat Comfort When Driving Vehicles

| Variable | Group | n | Pre-Intervention Mean±SD | Intervention Mean±SD | Analysis of Variance p-values[a] | | |
|---|---|---|---|---|---|---|---|
| | | | | | Period | Groups | Period ×Groups |
| Duration (hours/run) | NSP | 12 | 7.2±5.0 | 18.1±17.6 | 0.08 | 0.83 | 0.18 |
| | SP | 29 | 11.0±9.4 | 12.5±20.2 | | | |
| Frequency (runs/month) | NSP | 12 | 6.9±7.3 | 6.7±6.1 | 0.83 | 0.42 | 0.85 |
| | SP | 28 | 13.4±33.7 | 10.6±29.9 | | | |
| Distance (miles/run) | NSP | 12 | 695±932 | 633±415 | 0.39 | 0.60 | 0.22 |
| | SP | 29 | 576±603 | 940±649 | | | |
| Seat Comfort[b] | NSP | 12 | 1.7±0.6 | 1.4±0.7 | 0.69 | 0.21 | 0.18 |
| | SP | 35 | 1.8±1.0 | 2.0±1.1 | | | |

Legend: NSP – no seat pad; SP – seat pad
Notes:
[a]Two-way mixed model analysis of variance with repeated measures
[b]Comfort rating scale is 1 to 5 (low to high comfort)

(d) Table 31 shows a comparison of the two groups on a number of measures relating to their current activities. Because of the small sample sizes, questions related to driving and lifting immediately afterward (Question 38 on the Background Questionnaire and Question 19 on the

Post-Project Questionnaire) and to driving and pushing and pulling immediately afterward (Question 40 on the Background Questionnaire and Question 21 on the Post-Project Questionnaire) were reduced to "no" and "yes" responses. The "yes" category combined the "seldom," "occasionally," and "often" response categories.

(e) During the pre-intervention period, proportionally (1) more SP Soldiers reported experiencing vibrations or road jolts, (2) more NSP Soldiers had used a seat pad with a back rest, and 3) more SP Soldiers reported back pain after driving. During the intervention period, proportionally more SP Soldiers reported work requiring lifting and (as would be expected) reported using a seat pad with a back rest. Ninety percent of SP Soldiers reported using the seat pad while driving, but some NSP Soldiers (n=3) also used seat pads during the intervention period.

Table 31. Group Comparisons on Current Experience with Road Vibration, Lifting, Pushing/Pulling, Twisted Postures, Seat Cushion Use, Driving Breaks, and Back Pain While Driving

| Variable | Group | Category | Pre-Intervention (% in Category {n in category}) | Intervention (% in Category {n in category}) | Pre-Intervention Group Comparison p-value[a] | Intervention Group Comparison p-value[a] |
|---|---|---|---|---|---|---|
| Experienced Vibration/Jolts While Driving | NSP | No | 53.8 {7} | 46.2 {6} | 0.03 | 0.74 |
| | | Yes | 46.2 {6} | 53.8 {7} | | |
| | SP | No | 17.5 {7} | 36.8 {14} | | |
| | | Yes | 82.5 {33} | 63.2 {24} | | |
| Work Requires Lifting With Hands | NSP | No | 15.4 {2} | 23.1 {3} | 0.62 | 0.01 |
| | | Yes | 84.6 {11} | 76.9 {10} | | |
| | SP | No | 9.5 {4} | 0.0 {0} | | |
| | | Yes | 90.5 {38} | 100.0 {40} | | |
| Job Requires Driving Then Lifting Immediately Afterwards | NSP | No | 23.1 {3} | 92.3 {12} | 0.44 | 0.70 |
| | | Yes | 76.9 {10} | 7.7 {1} | | |
| | SP | No | 16.7 {7} | 7.7 {3} | | |
| | | Yes | 83.3 {35} | 92.3 {36} | | |
| Job Required Pushing or Pulling of Loads | NSP | No | 46.2 {6} | 46.2 {6} | 0.34 | 0.20 |
| | | Yes | 53.8 {7} | 53.8 {7} | | |
| | SP | No | 63.4 {26} | 67.5 {27} | | |
| | | Yes | 36.6 {15} | 32.5 {13} | | |
| Drive and Pushed or Pulled Immediately Afterwards | NSP | No | 53.8 {7} | 46.2 {6} | 0.26 | 0.47 |
| | | Yes | 46.2 {6} | 53.8 {7} | | |
| | SP | No | 46.3 {19} | 60.0 {24} | | |
| | | Yes | 53.6 {22} | 40.0 {16} | | |
| Sit in Twisted Posture for a Long Time While Driving | NSP | No | 46.2 {6} | 30.8 {4} | 0.76 | 0.53 |
| | | Yes | 53.8 {7} | 69.2 {9} | | |
| | SP | No | 40.5 {17} | 42.5 {17} | | |
| | | Yes | 59.5 {25} | 57.5 {23} | | |
| Currently Use Seat Pad With Backrest While Driving | NSP | No | 58.3 {7} | 75.0 {9} | <0.01 | <0.01 |
| | | Yes | 41.7 {5} | 25.0 {3} | | |
| | SP | No | 92.7 {38} | 10.0 {4} | | |
| | | Yes | 7.3 {3} | 90.0 {36} | | |
| Take Breaks on Drives >2 Hours | NSP | No | 92.3 {12} | 92.3 {12} | 0.66 | 0.99 |
| | | Yes | 7.7 {13} | 7.7 {1} | | |
| | SP | No | 83.3 {35} | 92.5 {37} | | |
| | | Yes | 16.7 {7} | 7.5 {3} | | |
| Have Back Pain After Driving/Riding | NSP | No | 46.2 {6} | 7.7 {1} | 0.02 | 0.26 |
| | | Yes | 53.8 {7} | 92.3 {12} | | |
| | SP | No | 14.3 {6} | 24.4 {10} | | |
| | | Yes | 85.7 {36} | 75.6 {31} | | |

Legend: NSP – no seat pad; SP – seat pad
Notes:
[a]From Fisher Exact Test

(f) Figure 10 shows that the proportion of SP Soldiers reporting back pain after driving or riding was slightly lower during the intervention period compared with the pre-intervention period. In contrast, the proportion of NSP Soldiers reporting back pain after driving or riding was higher during the intervention period compared with the pre-intervention period.

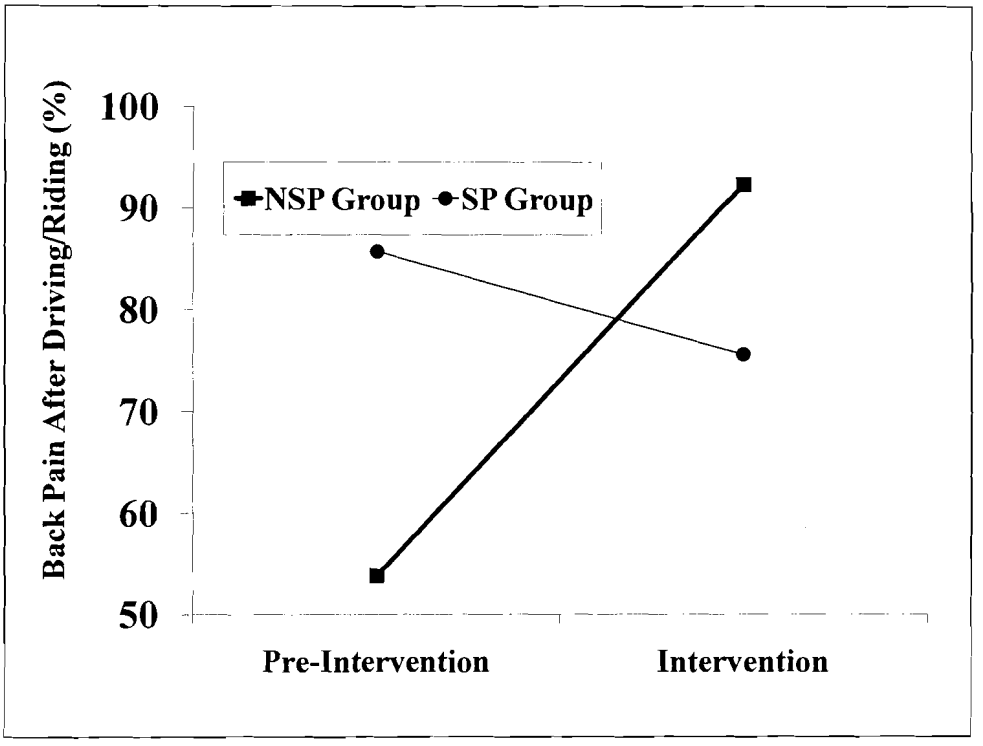



Figure 10. Proportion of SP and NSP Soldiers Reporting Back Pain after Driving or Riding in the Two Periods

(g) Table 32 shows the intensity of the back pain while driving (Question 44 on Background Questionnaire, Question 25 on Post-Project Questionnaire). This includes only those Soldiers who reported and rated LBP in both periods. There was a tendency for self-reported back pain intensity to be lower in both groups during the intervention period. This difference was about the same in both groups.

Table 32. Intensity of Back Pain While Driving

| Group | n | Pre-Intervention Mean±SD | Intervention Mean±SD | Analysis of Variance p-values | | |
|---|---|---|---|---|---|---|
| | | | | Period | Group | Period × Group |
| NSP | 7 | 6.0±2.1 | 5.3±2.1 | 0.09 | 0.65 | 0.87 |
| SP | 29 | 5.8±2.1 | 4.9±1.8 | | | |

Legend: NSP – no seat pad; SP – seat pad
Notes:
[a]Pain Scale is 1 to 10 (light to high pain)

(h) Table 33 shows activities other than driving that the Soldiers reported that put stress on their low backs. A Soldier could have had more than one response on this question. During the pre-intervention period, 8 NSP Soldiers and 15 SP Soldiers provided responses; during the intervention period, 9 NSP Soldiers and 20 SP Soldiers provided responses. Physical training (including weight-lifting, running, and calisthenics) accounted for 38% of all responses during the pre-intervention period and 30% of all responses during the intervention period. Lying down and sleeping accounted for 21% of all responses during the pre-intervention period and 14% of all responses during the intervention period. Gunning activities accounted for 7% of all responses during the pre-intervention period and 19% of all activities during the intervention period.

Table 33. Activities Other than Driving/Riding That Soldiers Reported Put Stress on Their Backs

| Activity | Pre-Intervention | | Intervention | |
|---|---|---|---|---|
| | No Seat Pad Group | Seat Pad Group | No Seat Pad Group | Seat Pad Group |
| Physical Training[a] | 1 | 4 | 0 | 2 |
| Weight Lifting | 2 | 1 | 0 | 2 |
| Running | 0 | 2 | 0 | 5 |
| Calisthenics | 0 | 1 | 0 | 2 |
| Lying Down/Sleeping | 2 | 4 | 0 | 5 |
| Gunner Activities | 0 | 2 | 2 | 5 |
| Bending/Lifting | 1 | 0 | 2 | 0 |
| Standing/Formations | 1 | 2 | 0 | 2 |
| Body Armor | 2 | 0 | 5 | 1 |
| Pulling | 1 | 0 | 0 | 0 |
| Truck Maintenance | 1 | 0 | 0 | 1 |
| Same Posture Too Long | 0 | 1 | 0 | 0 |
| Depends on Day | 0 | 1 | 0 | 0 |
| Road Marching | 0 | 0 | 0 | 3 |

Notes:
[a]Categories under physical training are exclusive of physical training alone.

(9) Ratings of the Seat Pad by the SP Group on the Post-Project Questionnaire

(a) The last page of the post-project questionnaire asked the SP Soldiers several questions on the use of the seat pad. Four SP Soldiers reported never using the seat pad and seven did not provide any responses on the page. There were 32 Soldiers in the SP group who reported using the seat pad an average±SD of 6.5±4.9 missions.

(b) The rating scales, average ratings provided by the Soldiers, and the range of ratings are shown in Table 34. For comfort, Soldiers tended to rate the pad to the left of neutral, indicating they were somewhat uncomfortable. On the ability to reduce shock and vibration, Soldiers tended to rate the seat pad between fair and neutral. On the ability of the set pad to reduce back pain/discomfort while driving, Soldiers reported a bit less pain and discomfort.

Table 34. Rating of the Seat Pad on Comfort, Ability to Reduce Shock and Vibration, and Effect on Back Pain/Discomfort

| Rating Types | Rating Scales | Average±SD Rating | Rating Ranges | | |
|---|---|---|---|---|---|
| | | | 0–4 (%) | 5 (%) | 6–10 (%) |
| Rating of the seat pad in terms of comfort | *Very uncomfortable* *neutral* *very comfortable*<br>0 1 2 3 4 5 6 7 8 9 10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | 4.2±2.5 | 41 | 38 | 22 |
| Rating of the ability of the seat pad to reduce shock and vibration[a] | *poor* *fair* *neutral* *good* *very good*<br>0 1 2 3 4 5 6 7 8 9 10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | 4.2±2.8 | 48 | 26 | 26 |
| Effect of the seat pad on typical back pain/ discomfort when driving | *less pain/discomfort* *no effect* *more pain/discomfort*<br>0 1 2 3 4 5 6 7 8 9 10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | 4.5±2.1 | 44 | 41 | 16 |

Notes:
[a]One Soldier did not provide a response

(c) The final two questions on the post-project questionnaire asked what the SP Soldiers liked and did not like about the seat pad. Appendix H contains the Soldiers' exact responses. Table 35 summarizes what Soldiers liked about the seat pads, placing the responses in Appendix H into broad categories. A total of 25 Soldiers provided 28 responses on what they liked about the pads (some Soldiers provided responses that fit into more than one category). Many of the Soldiers' favorable comments fell into the category of general comfort without a specific reason for that comfort. Where specific reasons were given, Soldiers liked the back support and found other uses for the seat pad such as use as a pillow and uses on office chairs.

Table 35. What Soldiers Reported Liking About the Seat Pad[a]

| Category | n | Proportion of All Responses (%) | Response Number (Refer to Appendix H) |
|---|---|---|---|
| General Comfort | 10 | 35.7 | 6, 7, 13, 14, 15, 17, 18, 19, 20, 23 |
| Back Support | 6 | 21.4 | 2, 8, 12, 16, 19, 22 |
| Other Uses | 4 | 14.3 | 5, 9, 11, 21 |
| Reduced Back Pain | 2 | 7.1 | 3, 4 |
| Reduced Vibration | 2 | 7.1 | 1, 20 |
| Helped Sit Upright | 1 | 3.6 | 4 |
| Portability | 1 | 3.6 | 10 |
| Increased Seat Height | 1 | 3.6 | 24 |
| Provided Seating Option | 1 | 3.6 | 25 |

Notes:
[a]A single Soldier could have provided responses in more than one category

(d) Table 36 summarizes what Soldiers disliked about the seat pads, placing the responses in Appendix H into broad categories. There were 29 Soldiers who provided 38 responses about what they disliked about the pads (some Soldiers provided responses that fit into more than one category). The most specific reason for disliking the seat pad was that it reduced headroom in vehicles the Soldiers drove. Soldiers also reported problems with the fit of the seat pad (e.g., too wide, not thick enough), the adjustment of the seat pad (e.g., slid around too much, constant adjustment needed), and that it caused too much sweat on the buttocks.

Table 36. What Soldiers Reported Disliking About the Seat Pad[a]

| Category | n | Proportion of All Responses (%) | Response Number (refer to Appendix H) |
|---|---|---|---|
| Reduced Headroom | 10 | 26.3 | 3, 5, 6, 8, 10, 17, 20, 22, 23, 24 |
| Fitting Problems | 8 | 21.1 | 1, 4, 12, 13, 14, 18, 19, 21 |
| General Discomfort | 6 | 15.8 | 6, 7, 9, 11, 14, 27 |
| Too Much Sweat on Buttocks | 4 | 10.5 | 2, 10, 18, 20 |
| Adjustment Problems | 4 | 10.5 | 11, 12, 16, 29 |
| Backrest/Seat Problems | 3 | 7.9 | 25, 26, 28 |
| Did Not Reduce Vibration | 2 | 5.3 | 11, 15 |
| Too Much Additional Equipment | 1 | 2.8 | 3 |

Notes:
[a]A single Soldier could have provided responses in more than one category

(e) In the final focus group session, Soldiers made several suggestions for improving the seat pads. These suggestions are in Appendix I.

e. Mission Surveys

(1) After 9 February 2009, no further mission surveys were received from the NSP group. They had been transferred to another unit, whose leadership was not aware of the project and did not require them to fill out the survey. Of the Soldiers who completed background and post-project surveys, only 8 mission surveys were completed by 7 of the 13 Soldiers in the NSP group. To increase statistical power, all surveys completed by the NSP group were considered and compared with mission surveys completed by SP group through 9 February 2009. An analysis of all mission surveys returned by the SP group before and after 9 February is in Appendix J.

(2) During the period between 21 October 2008 to 9 February 2009 (112 days), 52 mission questionnaires were returned by 31 NSP Soldiers and 242 mission questionnaires were returned by 50 SP Soldiers. All missions were reported to have been performed in HMMWV, with the exception of one mission in the SP group performed in a MRAP vehicle. SP group participants reported using seat pads on 47% of the missions and those who used the pads reported using them 78% of the time on those missions.

(3) Table 37 shows subject responses to questions on mission duration, mission distance, proportion of time driving and not driving, proportion of time on various types of roads (paved, secondary, cross-country), and road vibration. The SP group reported slightly shorter missions (1.2 days shorter), covering less distance (230 miles less). The proportion of time that Soldiers drove the vehicles was about the same for both groups, as was the proportion of time driving on paved roads, secondary roads, and cross country. The NSP group reported more road vibration than the SP group.

Table 37. Mission Driving Measures

| Question #. Variable | NSP Group | SP Group | Difference (%) | p-value[a] |
|---|---|---|---|---|
| Q6. Mission Duration (days) | 9.7±3.0 | 8.5±3.1 | 12.4 | 0.01 |
| Q7. Mission Time (hours/day) | 6.7±1.7 | 6.4±2.1 | 4.4 | 0.45 |
| Q8. Mission Distance (miles) | 1394±421 | 1164±626 | 16.5 | 0.02 |
| Q11a. Time Driving (%) | 37±40 | 34±41 | 8.1 | 0.40 |
| Q11b. Time Not Driving (%) | 64±40 | 62±42 | 3.1 | 0.91 |
| Q15a. Time On Primary (Paved) Roads (%) | 79±21 | 74±28 | 6.3 | 0.79 |
| Q15b. Time On Secondary (Dirt, Gravel) Roads (%) | 15±15 | 17±18 | 13.3 | 0.54 |
| Q15c. Percent of Time On Cross-Country Roads (%) | 5±8 | 6±16 | 20.0 | 0.71 |
| Q16. Rating of Road Vibration (1-10 scale) | 6.7±2.1 | 5.4±2.4 | 19.4 | 0.01 |

Legend: NSP – no seat pad; SP – seat pad
Notes:
[a]Independent sample t-test (Q6, Q7, Q8) or Mann Whitney U-Test (Q11a, Q11b, Q15a, Q15b, Q15c, Q16)

(4) Table 38 shows the reported back pain/discomfort just before and after the missions for the two groups (Questions 12 and 13 on the mission survey, respectively). ANOVA indicated a significant group × before/after mission effect. This is depicted in the graph in Figure 11. In the SP group, the Soldiers reported similar pain before and after the mission. In contrast, the NSP group reported an average doubling of pain after the missions. It should be noted that there were significant differences between the NSP and SP groups prior to the mission ($p<0.01$). To control for this, analysis of covariance (using the before mission measure as the covariate) still showed a significant difference between the groups on the after-mission ratings ($p<0.01$).

Table 38. Back Pain/Discomfort Before and After the Missions

| | NSP Group Mean±SD | SP Group Mean±SD | Analysis of Variance p-values | | |
|---|---|---|---|---|---|
| | | | Before/After Mission | Group | Before/After Mission × Group |
| Q12. Back Pain Prior to Mission | 2.4±1.7 | 3.0±2.7 | <0.01 | <0.01 | <0.01 |
| Q13. Back Pair After the Mission | 4.9±2.2 | 3.0±2.8 | | | |

Legend: NSP – no seat pad; SP – seat pad

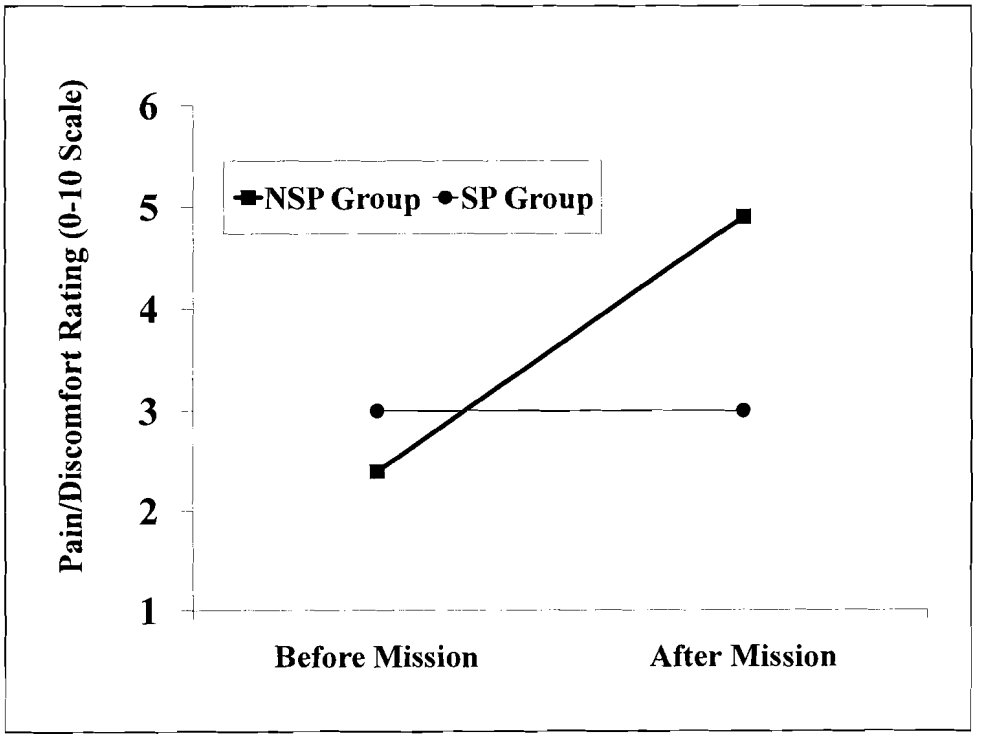



Figure 11. Ratings of Overall Back Pain/Discomfort Before and After the Missions

(5) As noted above, seat pads were used on only 47% of the missions. To determine whether the differences in back pain were associated with seat pad use, the SP group was separated into those who used the seat pad on the missions (SP users) and those who did not (SP non-users). Table 39 displays the back pain/discomfort ratings for the NSP group, the SP users, and the SP non-users; Figure 12 depicts the values in a graph. The 3 X 2 analysis of variance (groups × before/after mission) indicated that there was a significant interaction effect. The NSP group had higher post-mission scores, while the two SP groups (users, non-users) had similar pre- and post-mission scores.

(6) Prior to the missions, the SP users had higher back pain/discomfort ratings than the NSP group ($p=0.04$) and the SP non-users ($p<0.01$), with no difference between the NSP group and SP non-users ($p=0.97$). Because there were significant pre-mission differences, analysis of covariance was used to examine after-mission group differences with the before-mission ratings as the covariate. After controlling for before-mission pain ratings, there were significant after-mission differences between the NSP group and the SP users ($p<0.01$) and SP non-users ($p<0.01$). The after-mission difference between SP users and SP non-users was smaller ($p=0.12$)

Table 39. Back Pain/Discomfort Just Before and After the Missions

| | NSP Group[a] | SP Group (Seat Pad Users) [a] | SP Group (Seat Pad Non-Users) [a] | Analysis of Variance p-values [b] | | |
|---|---|---|---|---|---|---|
| | | | | Before/After Mission | Groups | Before/After Mission × Group |
| Back Pain Prior to Mission | 2.4±1.7[1] | 3.4±2.7[2] | 2.3±2.6[1] | <0.01 | <0.01 | <0.01 |
| Back Pain After the Mission | 4.9±2.2[2] | 3.3±2.5[1] | 2.6±3.0[1] | | | |

Legend: NSP – no seat pad; SP – seat pad

Notes:

[a]Different superscripts indicate significant difference between groups by Tukey Test ($p<0.05$). Same superscript indicate no significant difference ($p>0.05$).

[b]3 × 2 (groups × before/after mission) mixed model analysis of variance with repeated measures

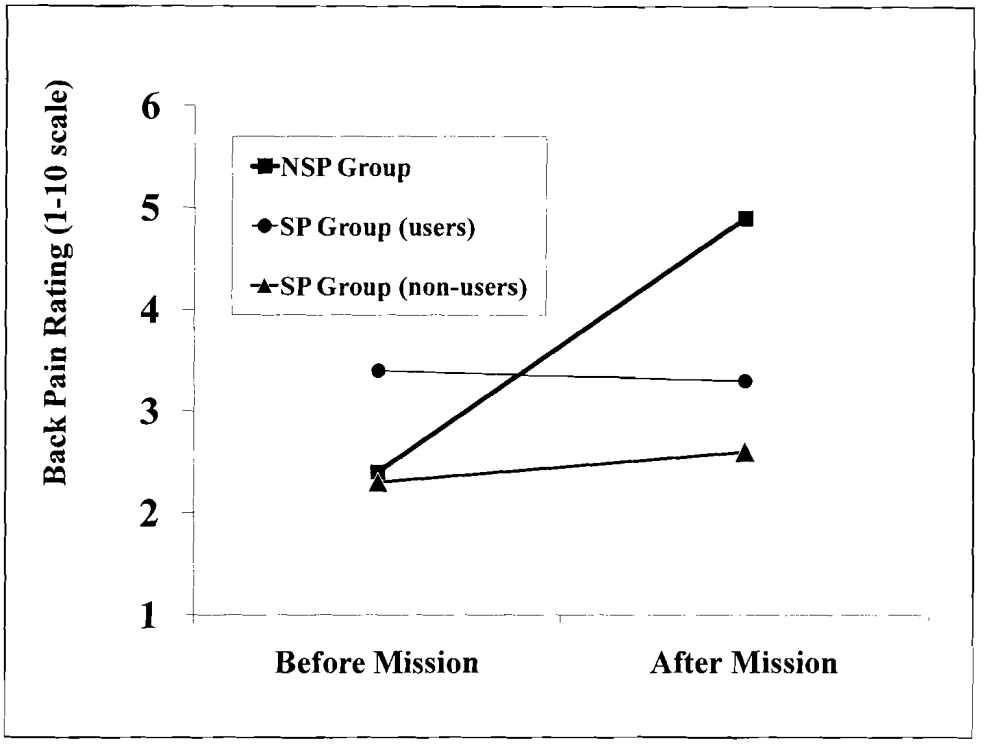



Figure 12. Ratings of Overall Back Pain/Discomfort Before and After the Missions With SP Group Separated Into Seat Pad Users and Non-Users

(7) Question 14 on the mission survey asked the Soldiers to rate pain/discomfort in various body regions during the missions. Table 40 shows a comparison of the NSP and SP groups on these ratings. Soldiers in SP group reported less pain/discomfort than the NSP group on all the measures, but these differences were larger for the head/neck, back, shoulder/upper arm, elbow/mid arm, and lower body (hip, leg foot) areas.

Table 40. Pain/Discomfort in Different Body Regions during the Missions

| Question Number. Variable | NSP Group | SP Group | Difference (%)[a] | p-value[b] |
|---|---|---|---|---|
| Q14a. Head/Neck Pain | 2.8±2.4 | 1.6±2.3 | 42.8 | <0.01 |
| Q14b. Upper/Mid Back Pain | 3.2±2.7 | 2.0±2.4 | 37.5 | <0.01 |
| Q14c. Low Back/Pelvic Pain | 4.7±2.3 | 3.0±2.9 | 36.2 | <0.01 |
| Q14d. Shoulder/Upper Arm Pain | 2.4±2.6 | 1.4±2.3 | 41.7 | <0.01 |
| Q14e. Elbow/Mid Arm Pain | 1.0±1.4 | 0.8±1.6 | 20.0 | 0.02 |
| Q14f. Forearm/Wrist Pain | 0.8±1.3 | 0.7±1.5 | 12.5 | 0.12 |
| Q14g. Hand Pain | 0.8±1.6 | 0.6±1.5 | 25.0 | 0.04 |
| Q14h. Upper Leg/Hip Pain | 2.5±2.6 | 1.2±2.0 | 52.0 | <0.01 |
| Q14i Mid Leg/Knee Pain | 3.8±2.8 | 1.2±2.0 | 68.4 | <0.01 |
| Q14j. Lower Leg/Foot Pain | 1.8±2.2 | 1.0±2.0 | 44.4 | <0.01 |

Legend: NSP – no seat pad; SP – seat pad
Notes:
[a]Calculated as NSP-SP/NSP X 100%
[b]Mann-Whitney U Test

(8) To determine whether the differences in regional pain were associated with seat pad use, the SP group was separated into those who used the seat pad on the mission and those who did not. Table 41 shows a comparison of three groups (NSP, SP seat pad users, SP seat pad non-users) on regional pain/discomfort. For the head/neck, back, shoulder/upper arm, and elbow mid-arm, the SP non-users had lower pain ratings that the other two groups and there were smaller difference between the SP users and the NSP group. For the upper leg/hip and the mid leg/knee regions, the NSP group reported more pain than the SP seat pad users and SP seat pad non-users.

Table 41. Pain/Discomfort in Different Anatomic Locations During the Missions

| Question #. Variable | NSP Group [a] | SP Group (Seat Pad Users)[a] | SP Group (Seat Pad Non-Users) [a] | p-value[b] |
|---|---|---|---|---|
| Q14a. Head/Neck Pain | 2.8±2.4[2] | 2.1±2.5[2] | 0.9±1.8[1] | <0.01 |
| Q14b. Upper/Mid Back Pain | 3.2±2.7[2] | 2.4±2.5[2] | 1.5±2.2[1] | <0.01 |
| Q14c. Low Back/Pelvic Pain | 4.7±2.3[2] | 3.6±2.9[2] | 2.2±2.8[1] | <0.01 |
| Q14d. Shoulder/Upper Arm Pain | 2.4±2.6[2] | 1.7±2.5[2] | 0.9±1.8[1] | <0.01 |
| Q14e. Elbow/Mid Arm Pain | 1.0±1.4[2] | 0.8±1.7[2] | 0.7±1.5[1] | 0.03 |
| Q14f. Forearm/Wrist Pain | 0.8±1.3 | 0.7±1.6 | 0.6±1.4 | 0.17 |
| Q14g. Hand Pain | 0.8±1.6 | 0.6±1.5 | 0.6±1.4 | 0.09 |
| Q14h. Upper Leg/Hip Pain | 2.5±2.6[2] | 1.1±1.8[1] | 1.1±2.2[1] | <0.01 |
| Q14i Mid Leg/Knee Pain | 3.8±2.8[2] | 1.1±2.0[1] | 1.7±2.4[1] | <0.01 |
| Q14j. Lower Leg/Foot Pain | 1.8±2.2[c] | 1.0±2.0[c] | 1.0±2.0[c] | 0.05 |

Legend: NSP – no seat pad; SP – seat pad
Notes:
[a]Different superscripted numbers indicate significant differences between groups ($p<0.05$) from Mann-Whitney U Test
[b]Kruskal-Wallis Test
[c]Despite significant p-value from Kruskal-Wallis Test, Mann-Whitney U Test did not indicate significant difference at $p<0.05$

(9) Questions 17, 18 and 19 on the Mission Questionnaire asked Soldiers in the SP group to rate the seat pad on (1) its comfort, (2) its ability to reduce shock and vibration, and (3) its effect on the typical back pain/discomfort the Soldier experienced while driving. Table 42 shows that on average, Soldiers were neutral on the comfort of the seat pad and on the ability of the seat pad to reduce shock and vibration. Soldiers tended to report that the seat pad did slightly reduce back pain/discomfort while driving.

Table 42. Rating of the Seat Pad on Comfort, Ability to Reduce Shock and Vibration, and Effect on Back Pain/Discomfort

| Rating Types | Rating Scales | Average±SD Rating | Rating Ranges | | |
|---|---|---|---|---|---|
| | | | 0–4 (%) | 5 (%) | 6–10 (%) |
| Q17. Rating of the seat pad in terms of comfort | *Very uncomfortable* *neutral* *very comfortable*<br>0 1 2 3 4 5 6 7 8 9 10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | 5.0±2.9 | 36 | 24 | 40 |
| Q18. Rating of the ability of the seat pad to reduce shock and vibration | *poor* *fair* *neutral* *good* *very good*<br>0 1 2 3 4 5 6 7 8 9 10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | 4.9±2.7 | 34 | 29 | 37 |
| Q19. Effect of the seat pad on typical back pain/ discomfort when driving | *less pain/discomfort* *no effect* *more pain/discomfort*<br>0 1 2 3 4 5 6 7 8 9 10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | 4.0±2.7 | 48 | 29 | 23 |

f. Low Back Pain Risk Controlling for Group Differences

(1) There were some pre-intervention differences between the NSP and SP groups. Compared with the NSP group, the SP group was younger, ran the 2-mile run faster, had less time in service, had less time in their MOS, and reported proportionally more individuals with road vibration at work and fewer individuals previously using seat pads. Logistic regression was used to examine reported LBP during the intervention period while controlling for these variables. Table 43 shows the univariate and multivariate odds ratios. The multivariate odds ratios included in the model group, age, 2-mile run time, time in service, time in MOS, previous experience with road vibration, and prior seat pad use.

(2) The univariate analyses showed lower risk in the SP group compared with the NSP group, although none of the comparisons were statistically significant. Of note, risk of LBP while driving was 3.8 times higher in the NSP group compared with the NSP group. In the multivariate analyses, there was some further reduction in LBP risk in the 7-day model and the "while driving" model, but there was a slight increase in risk in the overall 6-month model. Importantly, risk of LBP while driving in the NSP group was 6.7 times higher than in the SP group.

Table 43. Univariate and Multivariate Logistic Regression Models with Low Back Pain as the Dependent Variable

| Dependent Variable[a] | Group | Univariate[a] | | | Multivariate[b] | | |
|---|---|---|---|---|---|---|---|
| | | n | Odds Ratio (95%CI) | p-value | n | Odds Ratio (95%CI) | p-value |
| LBP in Last 7 Days | NSP<br>SP | 13<br>43 | 1.00<br>0.47 (0.09-2.44) | 0.37 | 11<br>34 | 1.00<br>0.19 (0.02-1.85) | 0.15 |
| LBP in Last 6 Months | NSP<br>SP | 13<br>43 | 1.00<br>0.94 (0.17-5.17) | 0.94 | 11<br>34 | 1.00<br>1.00 (0.11-9.45) | 0.99 |
| LBP While Driving in Last 6 Months | NSP<br>SP | 13<br>41 | 1.00<br>0.26 (0.03-2.24) | 0.22 | 11<br>33 | 1.00<br>0.15 (0.01-2.29) | 0.17 |

Legend: LBP – Low back pain; NSP – no seat pad; SP – seat pad
Notes:
[a]Includes only group in the model
[b]Includes in the model group, age, two-mile run time, time in service, time in MOS, prior road vibration at work and prior seat pad use.

8. DISCUSSION.

a. Seat Pad Evaluation

(1) The primary purpose of the present investigation was to determine whether or not back complaints among drivers could be reduced by the Skydex® seat pad purchased by the transportation unit. Overall, there was little difference in reported LBP between those in the SP

group and those in the NSP group over the pre-intervention period or the intervention period. This was true if Soldiers were asked about LBP in the last 7 days (Table 11) or about LBP during the last 6 months (Table 15). However, graphing the change in back pain from the pre-intervention to the intervention period showed a considerably different pattern for the two groups. The NSP group showed an increase in the proportion of Soldiers reporting back pain in the intervention period (Figures 8 and 9). In contrast, the SP group began with a larger proportion of Soldiers reporting back pain compared with the NSP group and that proportion declined (7 day time, Figure 8) or stayed about the same (6 month time, Figure 9) over the intervention period. In fact, 25% (3 of 12) of NSP Soldiers who did not report LBP in the pre-intervention period reported it in the 6-month intervention period compared with only 5% (2 of 43) of SP Soldiers. The proportion of NSP and SP Soldiers who reported LBP in the pre-intervention period but none in the intervention period (6 month time) was similar (NSP 8% (1 of 13), SP 5% (2 of 43)).

(2) Responses to questions asking Soldiers about back pain after driving or riding on background and post-project showed a similar pattern to that discussed above. The proportion of NSP Soldiers reporting pain after driving or riding increased from 54% during the pre-intervention period to 92% in the intervention period. On the other hand, the proportion of SP Soldiers reporting pain during driving or riding decreased from 86% during the pre-intervention period to 76% in the intervention period (Table 31, Figure 10). Of the Solders reporting pain, the self-rated intensity was similar in the two groups during the pre-intervention and intervention periods, and there was a similar trend suggesting reduced pain intensity in both groups during the intervention period (Table 32).

(3) Although these differences were not statistically significant, these findings might be considered favorable for use of the seat pad in that they may suggest that the seat pads mitigate low back problems among those who have had previous low back problems. Further support for this hypothesis comes from the mission surveys. On the mission surveys, subjective ratings of LBP before and after driving missions demonstrated the same general pattern as the background and post-project questionnaires. That is, the NSP group showed an overall post-mission increase in back pain while the SP group showed no change in the pain rating. (Of course, on the mission surveys the outcome variable was a pain rating on a 10-point scale rather than the simple yes/no pain response on the background and post-project surveys). The interaction was statistically significant (Table 38 and Figure 11). When the SP group was separated into those who reported using and not using the seat pads on the missions, two interesting facts emerged. First, the SP users reported higher back pain before the missions. This suggests that those with prior mission back pain were more likely to use the seat pads. Second, after the mission, there was virtually no change in the pain rating for the SP users or non-users (Table 39 and Figure 12). This suggests that the seat pad did mitigate pain in those with higher before-mission pain. However, this does not explain why the SP non-users had no change in their pain rating, while the NSP group reported an increase.

(4) To further explore the idea that the seat pad mitigated pain in Soldiers experiencing higher levels of back pain, Soldiers were separated into those who had pain ratings above and below a value of 3 before the missions on the mission questionnaire. Table 44 and Figure 13 show the results. A three-factor analysis of variance indicated a significant pain level × group interaction and a significant three-way interaction. The critical comparison is with SP users and SP non-users. The two groups began the missions with virtually identical average pain levels but, while the SP users slightly reduced their pain level after missions, the SP non-users increased it. A two-way analysis of variance comparing only SP users and SP non-users before and after missions also showed a significant interaction ($p<0.01$). These data again support the hypothesis that the seat pads mitigated pain among those with higher before mission pain.

Table 44. Back Pain Rating Before and After Missions With Groups Separated into Lower and Higher Before Mission Pain and Seat Pad Users and Non-Users

| Time and Pain Rating | Group | Before Mission M±SD | After Mission M±SD | Analysis of Variance p-values[a] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Before/ After | Pain Level | Group | Pain Level × Group | Pain Level × Before/After | Before/After × Group | Pain Level × Group × Before/ After |
| Before Mission Back Pain <3 | NSP | 1.3±0.8 | 4.0±2.3 | <0.01 | <0.01 | <0.01 | <0.01 | 0.10 | <0.01 | 0.03 |
| | SP Users | 0.6±0.9 | 1.1±1.5 | | | | | | | |
| | SP Non-Users | 0.4±0.7 | 0.5±1.1 | | | | | | | |
| After Mission Back Pain >3 | NSP | 3.9±1.3 | 6.1±1.4 | | | | | | | |
| | SP Users | 5.2±1.7 | 4.6±2.0 | | | | | | | |
| | SP Non-Users | 5.1±1.7 | 5.6±2.2 | | | | | | | |

Legend: NSP – no seat pad; SP – seat pad

Notes:

[a]Three-way mixed model analysis of variance with repeated measures on the Before/After factor

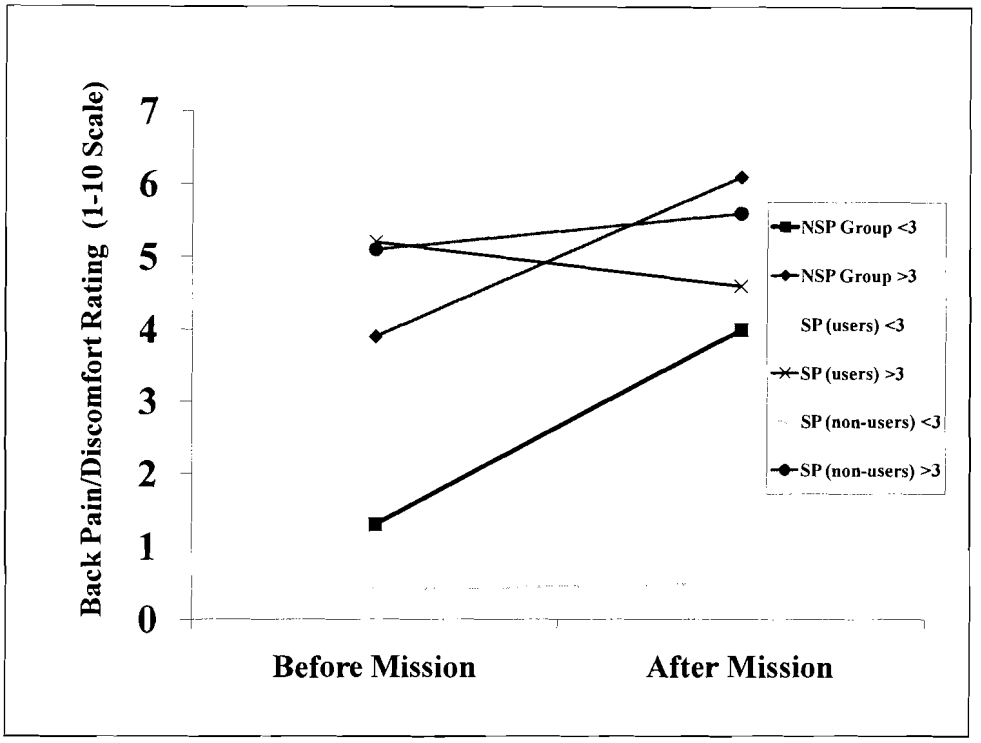



Figure 13. Before and After Mission Back Pain Ratings Among Soldiers with Higher Pre-Mission Pain Ratings (>3) with SP Group Separated into Seat Pad Users and Non-Users

(5) Interestingly, Figure 13 shows that the NSP group with low pain before the missions reported an after-mission increase their pain level. This is in contrast to the SP Soldiers with low before-mission pain, who showed no change in pain after the mission. Two factors should be considered here. First, the low-pain NSP group still had a significantly higher pre-mission pain rating compared with the SP users and SP non-users ($p<0.01$, one-way analysis of variance). It is possible that even this relatively low initial pain level was exacerbated by the mission. Second, the NSP group appeared to have less pre-intervention driving exposure compared with the SP group. Evidence for this is that (1) the NSP group reported less pre-intervention exposure to vibration and jolts compared with the SP group (Table 31), (2) 46% of the NSP group reported an MOS other than transportation (MOS 88 series), compared with only 2% in the SP group (Table 23), and (3) although not statistically significant, pre-intervention reports of LBP in the last 7 days and last 6 months were lower in the NSP group compared with the SP group (Tables 11 and 15). Several studies have shown that LBP incidence increases as the total exposure to whole body vibration increases[20, 23, 26, 28, 38, 41]. It is possible that the additional driving exposure during the intervention period increased LBP in the NSP group.

b. Subjective Ratings of the Seat Pads

(1) The Solders did not rate the seat pad favorably on either comfort or its ability to reduce shock and vibration. For comfort, the average response on the post-project questionnaire ratings tended toward less comfort and on the mission questionnaires the average response was exactly neutral. For ability to reduce shock and vibration, the average response on the post-project questionnaire tended toward neutral to fair and on the mission questionnaires the average response was virtually neutral. Previous research suggested that a lumbar support combined with a seat inclination of 120 degrees backward reduced vertical accelerations of the lumbar spine and the total vibration dose[81, 82]. However, Soldiers in the present study were apparently unable to subjectively feel any reduced vibration from the lumbar support or cushioning elements, if indeed any reduction in vibration actually occurred.

(2) On the other hand, Soldiers' ratings on the ability to reduce back pain while driving were slightly better: on both the post-project questionnaire and the mission questionnaires, the average responses tended toward less back pain/discomfort. The ratings on the pad's ability to reduce back pain could be due to the lumbar support, the cushioning elements, or both. Biomechanical studies have shown that lumbar supports moved the lumbar spine toward greater lordosis[75-77] and lordotic postures held for a period of time reduced back pain[78]. Lumbar supports also reduced lumbothoracic muscle activity (EMGs) and disc pressures[61, 79], which could have influenced the subjective ratings in the present study. The cushioning elements could have assisted in the reported reduction in back pain/discomfort if the elements did, in fact, reduce vibration.

c. Group Differences

(1) The transportation unit selected the two groups for the project based on troop availability. They were not randomly selected. The two units were geographically separated within Camp Arifjan (by about 1 mile) minimizing the possibility that SP Soldiers might give seat pads to those in the NSP group. There were some notable group differences at the start of the investigation. The NSP group Soldiers were all National Guardsmen, while the SP group Soldiers were all active Army. Compared with the SP group, the NSP group were older (6 years), less aerobically fit (ran the 2-mile APFT 1.2 minutes slower), had more time in service (6 years), reported less experience with vibrations and jolts at work, and were more likely to have used seat pads previously. Virtually all of the SP group (98%) reported being drivers (MOS 88M), while almost half of the NSP group (46%) were working as drivers outside their MOS.

(2) The logistic regression analyses suggested that, once these factors were controlled for, the SP group tended to have lower risk than the NSP group for LBP in the last 7 days and while driving. Risk for LBP in the last 6 months (intervention period) was essentially the same in the NSP and SP groups. Although the risk differences were not statistically significant (presumably

because of the small sample size), LBP during driving among SP group was 0.15 times that of the NSP group. Tiemessen et al.[28] found little association between self-reported LBP in the last 12 months and whole body vibration exposure; however *driving-related* LBP increased with either more years of exposure, more daily hours of exposure, or more total vibration dose.

(3) When asked about the number of episodes, duration, or severity of LBP in the last 7 days, there tended to be a decline in all of these subjective measures for the SP group, while the NSP group reported an increase (Table 14). However, when asked about the number of episodes over the last 6 months (entire intervention period), both the SP and NSP groups reported an increase (Table 19). Nonetheless, for the SP group, the duration and severity of LBP over the 6-month period tended to decline, while for the NSP group there was little or no difference between periods (Table 19). None of these differences were statistically significant except for severity of LBP while sleeping, where the SP group reported a decline in severity, with no change in severity for the NSP group.

(4) A possible confounder in the project was the fact than some Soldiers in both groups reported using seat pads at the start of the project: 5 of the 13 NSP Soldiers (39%) and 3 of 41 SP Soldiers (7%). Figure 14 shows that when the Soldiers reporting seat pad use prior to the project were eliminated, the same pattern was still evident as with these Soldiers included (Figure 10). That is, there was higher pre-intervention back pain in the SP group ($p=0.04$) with no difference in the intervention period ($p=0.99$). The interaction ($p<0.01$) indicated that the NSP group increased the proportion of Soldiers reporting back pain during the intervention period, while the SP group had a slight decrease.

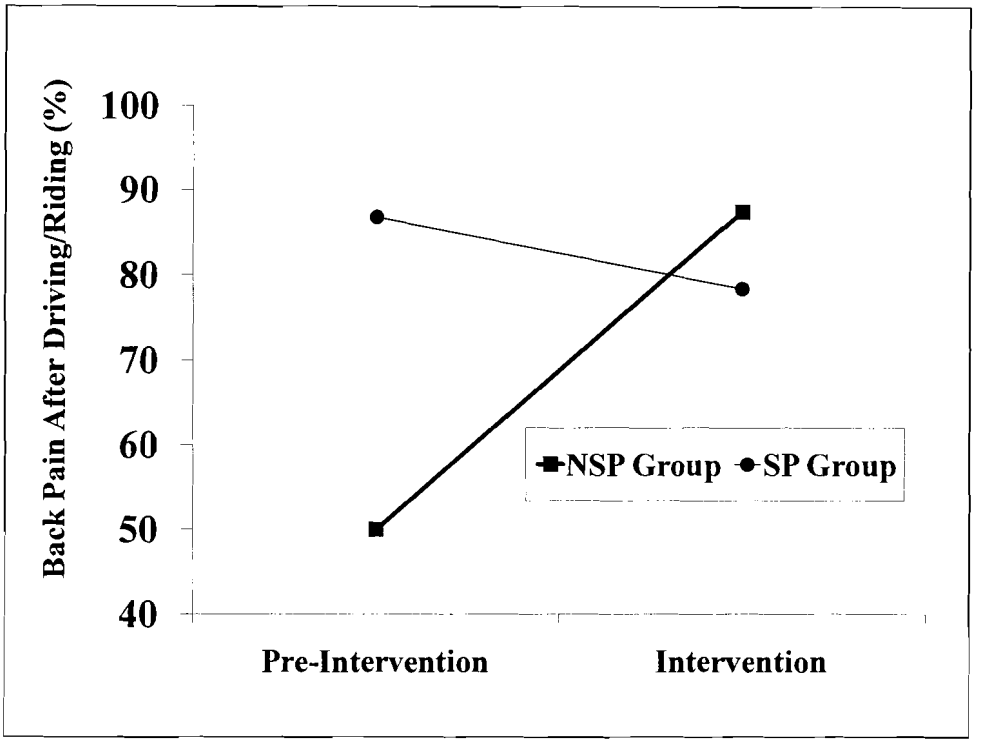



Figure 14. Back Pain While Driving with Soldiers Reporting Previous Seat Use Eliminated

d. Back Pain among Drivers

(1) A secondary purpose of this project was to obtain baseline information on vehicle driver back pain. To fulfill this purpose, the background questionnaire was analyzed for baseline information on Soldier back pain. Since this was before the intervention, the NSP and SP groups were combined for this analysis (n=98). Results are shown in Table 45. Soldiers reported a 76% prevalence of LBP in the last 7 days, an 80% prevalence of LBP in the last 6 months, and an 82% prevalence of LBP currently while driving or riding in vehicles. However, this pain was reported as "constant" by only 16% in the last 7 days and 13% in the last 6 months. Even fewer reported that they had been profiled for LBP in the last 7 days (4%) or last 6 months (8%).

Table 45. Groups Comparisons on Low Back Pain Questions on the Background Questionnaire

| Question #. Variable | Category | During Last 7 Days | | During Past 6 Months | | While Driving | |
|---|---|---|---|---|---|---|---|
| | | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) |
| Q20a. Aches, Pain, Discomfort with LB | Never | 24 | 23.8 | 20 | 20.4 | | |
| | Seldom | 36 | 35.6 | 39 | 39.8 | | |
| | Often | 41 | 40.6 | 39 | 39.8 | | |
| Q20b. Frequency of LBP | Constant | 12 | 15.6 | 10 | 13.3 | | |
| | Episodic | 56 | 73.7 | 61 | 81.3 | | |
| | Once | 8 | 10.5 | 4 | 5.3 | | |
| Q20e Profiled for LBP | No | 72 | 96.0 | 67 | 91.7 | | |
| | Yes | 3 | 4.0 | 6 | 8.2 | | |
| Q44. Currently Have LBP Driving/Riding | No | | | | | 18 | 18.4 |
| | Yes | | | | | 80 | 81.6 |

Legend: LBP=Low Back Pain, LB=Low Back

(2) Table 46 shows studies that have examined the prevalence of low back problems among vehicle drivers and includes data from the present investigation in the last row. It is obvious that there are considerable differences in the definitions of back problems, time periods over which the data were queried, and methods used to collect information. However, it is possible to make some broad comparisons between these past studies and the present project. Studies that asked about lumbar pain in the last seven days[11, 26, 29] found prevalences ranging from 17% to 62% compared with 76% in the present study. No studies were found asking about low back problems in the last 6 months; however, studies examining LBP in the last year[11 20 26, 28, 32, 34] reported prevalences to range from 27% to 84% compared with the 6-month prevalence of 80% in the present investigation. Finally, prevalence from studies reporting on drivers currently experiencing pain while driving[22, 28, 33] ranged from 37% to 81% compared with 82% in the present study.

(3) These comparisons suggest that the prevalence of self-reported low back problems tends to be higher among these Army vehicle drivers than among other non-military vehicle drivers sampled. At least two factors might partially explain this higher prevalence. First, the question on the Background questionnaire was broadly worded. The question asked "Did you have aches, pain, discomfort or other symptoms with your low back?" Unlike many civilian drivers, Soldiers do a variety of tasks besides driving, as evidenced by response to the questions on lifting and pushing/pulling. For example, over 84% of Soldiers reported that their work required lifting with their hands (Table 31). Some of the positive responses on LBP may have been due to delayed onset muscle soreness induced by doing atypical heavy work activities[97]. Second, it is of note that few, if any, of the previous studies appear to have examined long-haul driving, which may be the most appropriate comparison group for the Soldiers in the present project. Long-haul driving would require sitting for prolonged periods of time with minimal opportunity for changes of position. Several studies[22, 31, 33] have examined truck drivers, but do

not provide the distances these individuals drove, which would allow for more appropriate comparisons with the present study. Some studies do provide vibration information[22, 41].

Table 46. Studies Examining Prevalence of Low Back Problems Among Vehicle Drivers

| Study | Group/Study Location (if Provided) | Method to Obtain Low Back Problem | Prevalence |
|---|---|---|---|
| Netterstrom and Juel 1989 (18) | 2,465 Male Urban Bus Drivers in Denmark | Hospital Discharge Records for Low Back Trouble | Hospital Discharge With Low Back Trouble (Mostly Lumbar Disc Herniations) Over 7 Years=2% |
| Boshuizen et al. 1990 (23) | 450 Tractor Drivers | Questionnaire on LBP | Regular Back Pain=38%<br>LBP=31%<br>Prolapsed Disc=8% |
| Anderson (16) | 128 Bus Drivers<br>California, USA | Physical Examination and Interview on Spinal and Lumbar Pain | Any Spinal Pain=81%<br>Lumbar Pain=66% |
| Pietri et al. 1992 (25) | 1709 Commercial Travelers<br>France | Annual Medical Examination | LBP in Last Year=27% |
| Bovenzi and Zadini (11) | 234 Male Bus Drivers<br>Triest, Italy | Modified Nordic Musculoskeletal Questionnaire | Lifetime LBP Symptoms=84%<br>Lifetime Acute LBP=39%<br>Lifetime LBP=36%<br>12-Month LBP Symptoms=83%<br>12-Month Acute LBP=35%<br>12-Month LBP=40%<br>12-Month Treated LBP=61%<br>7-Day LBP Symptoms=62% |
| Bovenzi (11) | 598 Vehicle Drivers (quarry vehicles,forklifts,trucks, buses)<br>Italy | Modified Nordic Musculoskeletal Questionnaire | LBP Last Year=44%<br>High Intensity LBP Last Year=26%<br>LBP Disability Last Year=18% |
| Bovenzi and Betta 1994 (20) | 1,155 Tractor Drivers<br>Italy | Modified Nordic Musculoskeletal Questionnaire | LBP Lifetime=81%<br>LBP 12-Month=72%<br>LBP 1-Month=39%<br>Transient LBP=67%<br>Chronic LBP=37%<br>Sciatic Pain=16%<br>Acute LBP=36%<br>Treated LBP=25%<br>LBP Sick Leave=12%<br>Disc Protrusion=7% |
| Magnusson et al. 1996 (22) | 111 Bus Drivers<br>117 Truck Drivers<br>Sweden and US | Modified Nordic Musculoskeletal Questionnaire | LBP During Present Job:<br>Bus Truck<br>US 81% 50%<br>Sweden 49% 59% |
| Burton et al. 1996 (40) | 1508 Ulster Police<br>377 Manchester Police | Questionnaire | 1 Episode: Ulster=11%; Manchester=19%<br>Episodic: Ulster=59%; Manchester=58%<br>Persistent: Ulster=31%; Manchester=23% |
| Krause et al. 1997 (30) | 1,463 Transit Operators<br><br>San Francisco, USA | Questionnaire About Current Back or Neck Pain | Current Back or Neck Pain=15% |

| | | | |
|---|---|---|---|
| Krause et al. 1998 (13) | 1,449 Transit Operators<br>San Francisco, USA | Workman's Compensation Claims for Low Back Spinal Injury | 5-Year Low Back Spinal Injury=58% |
| Schwarze et al. 1998 (41) | 159 Fork Lifts Operators<br>64 Truck Drivers<br>165 Heavy Equipment Operators | Interview, clinical exam, lumbar X-ray, health insurance claims | Lumbar Syndrome<br>Fork Lift=65%<br>Truck=63%<br>Heavy Equipment=61% |
| Miyamoto et al. 2000 (31) | 181 Truck Drivers<br>Japan | Questionnaire on LBP in last month | LBP in Last Month=50% |
| Porter and Gyi 2002 (27) | 113 Work Drivers<br>England | Nordic Musculoskeletal Questionnaire | Current LBP=30%<br>Lifetime LBP=61%<br>LBP Absence (mean days)=16 |
| Krause et al. 2004 (8) | 1,233 Transit Operators<br>San Francisco, USA | Incidence of a Compensated Claim of a Low Back Injury Over 7.5 Years (ICD-9 Codes) | Compensated Low Back Injury=27%<br>(331/1,233) |
| Chen et al. 2005 (32) | 1242 Taxi Drivers<br>Professional Drivers<br>Taipei, Tiawan | Modified Nordic Musculoskeletal Questionnaire | LBP 12-Months<br>Drivers=33%;<br>Taxi Drivers=51% |
| Chen et al 2005 (37) | 224 Taxi Drivers<br>Taipei, Tiawan | Structured Interview | LBP Leading to Medical Attention or Absence from Driving in Last Month=25% |
| Andrusaitis et al. 2006 (33) | 410 Truck Drivers<br>San Paulo, Brazil | Questionnaire asking if subject experienced LBP as a driver | LBP in Experience as a Driver=59% |
| Robb and Mansfield (34) | 192 Truck Drivers<br>England | Nordic Musculoskeletal Questionnaire | Lifetime LBP=70%<br>LBP in Last Year=60%<br>LBP in Last 7 Days=24%<br>LBP Affecting Activity=12% |
| Tamrin et al. 2007 (35) | 760 Bus Drivers<br>Malaysia | Nordic Musculoskeletal Questionnaire | Lower Back Musculoskeletal Disorders=60% |
| Miyamoto et al. 2008 (29) | 1,334 Taxi Drivers<br>Japan | Roland-Morris Questionnaire | LBP in Last Week=21% |
| Tiemessen et al. 2008 (28) | 229 Male Drivers<br>Netherlands | Questionnaire Disability Scale | LBP In Last Year=58%<br>Driving-Related LBP=37% |
| Okunribido et al. 2008 (26) | 60 Police<br>65 Tractor Drivers<br>70 Track/Van Drivers<br>68 Bus Drivers<br>34 Construction Drivers<br>30 Taxi Drivers<br>59 Non-Drivers (Controls) | Questionnaire on LBP | LBP: Last 7 Days / Last Year<br>Police 19% / 46%<br>Tractor Drivers 17% / 43%<br>Track/Van Drivers 32% / 50%<br>Bus Drivers 31% / 59%<br>Construction Drivers 23% / 44%<br>Taxi Drivers 44% / 63%<br>Non-Drivers (Controls) 37% / 58% |
| Present Study | 98 Soldiers/Vehicle Drivers Serving in Kuwait | Questionnaire on LBP | LBP in Last 7 Days=76%<br>LBP in Last 6 Months=80%<br>LBP Currently While Driving= 82% |

Legend: LBP – Low back pain

(4) For Soldiers reporting LBP, Table 47 shows the episodes, duration, and severity reported on the background questionnaire for the combined sample of Soldiers (n=98). The highest severity of LBP was reported while driving and the lowest while walking.

Table 47. Episodes, Duration and Severity of Low Back Pain Among Drivers (Background Questionnaire)

| Question #. Variable[a] | During Last 7 Days | | During Past 6 Months | |
|---|---|---|---|---|
| | n | Mean±SD | n | Mean±SD |
| Q20c Episodes of LBP (n) | 75 | 3.2±2.9 | 62 | 19.0±34.6 |
| Q20d Duration of LBP (days) | 75 | 2.9±2.5 | 65 | 22.7±46.6 |
| Q20i Severity LBP Driving | 77 | 4.3±2.5 | 78 | 4.2±2.4 |
| Q20j Severity LBP Lifting | 77 | 3.2±2.4 | 78 | 3.4±2.5 |
| Q20k Severity LBP Walking | 77 | 1.8±1.8 | 78 | 1.9±2.1 |
| Q20l Severity LBP Standing | 77 | 3.1±2.8 | 78 | 3.1±2.7 |
| Q20m Severity LBP Sitting | 77 | 3.6±2.7 | 77 | 3.4±2.6 |
| Q20n Severity LBP Sleeping | 77 | 3.4±2.9 | 78 | 3.5±2.7 |

Legend: LBP – Low back pain
Notes:
[a]Severity rating scales are 1 to 10 (low to high)

e. Driving Exposure

(1) A final purpose of this project was to obtain exposure rates for vehicle drivers. Exposure in this sense was the self-reported mission time, duration, mileage, and time driving paved roads, secondary roads, and cross-country. More exposure to driving either in terms of times per week, hours per week, or miles driven per week has been associated with low back problems in many[8, 25-28, 30-33], but not all[13, 29, 34-38], previous investigations of vehicle drivers.

(2) Table 37 provides this information by group. To obtain a more comprehensive picture, all mission surveys were combined. When this was done, Soldiers' average (±SD) mission lasted 8.5±2.9 days, with daily driving durations of 6.6±2.3 hours, and driving distances of 1144±564 miles. Soldiers reported spending 35.2±41.4% of the time driving and 60.0±42.9% of the time riding. The reported proportions of time driving on paved roads, secondary roads, and cross-county were 74.0±28.8%, 17.7±19.5%, and 6.8±16.0%, respectively.

(3) Some doubt must be cast on the mission time, duration, mileage estimates. It can be calculated that an average mission lasted 56 hours (8.5 days × 6.6 hours/day). If the average distance was 1144 miles, then Soldiers were driving their vehicles an average of about 20 miles/hour (1144 miles/56 hours). It is unlikely that Soldiers were driving this slowly, suggesting that the mission times or durations were overestimated or the distances underestimated. Soldiers had a mandated maximal speed of 55 miles per hour.

f. Limitations

(1) This project had severe limitations that should be considered in interpreting the data. A major problem was the fact that 40 of the NSP group did not complete the post-project questionnaire. This was 75% of the original cohort of 53 leaving only 13 Soldiers with complete pre-intervention and intervention data. With only 13 NSP and 43 SP Soldiers statistical power was very limited To achieve statistical power of 80% in a 2 × 2 comparison (assuming alpha=0.05 and a two-tailed test), one group would have to differ from the other by a factor of 2.2. For example, this ratio was achieved in Table 15 (bottom) where 70% of NSP group and 31% of the SP group in the intervention period reported that movements aggravated back pain (70%/31%=2.3, p=0.03). Despite the low statistical power, there were some findings of interest. Because of this, much of the analysis of LBP differences between groups focused on trends in the data.

(2) Another limitation was the low number of mission surveys returned by the NSP group. We received only 52 NSP mission surveys from the NSP group. From 2 to 15 November, 67% of these were received and between 2 and 9 January 2009 we received the remainder. The representativeness of these questionnaires is not clear.

9. CONCLUSIONS

a. There were severe limitations to this project relating to (1) loss to follow-up of 75% of the original NSP group and (2) the limited number of mission surveys returned by the NSP group. Nonetheless, the present project provided some limited support for the concept that the Skydex® seat pad may reduced back pain during long distance drives among drivers who had high pre-driving levels of back pain.

b. There are several problems with the seat pad. The major one was that the seat pad reduced headroom in the HMMWV. Soldiers also complained of fitting and adjustment problems (pad was too wide, slipped around on the seat) and that it caused too much sweat.

c. The incidence of self-reported back pain in these Soldiers was much higher than that reported by civilian drivers.

10. RECOMMENDATIONS. Seat pads of different types should be further evaluated among long-distance drivers, especially those who have high levels of pre-mission back pain. The seat pad should be further tested in vehicles that provide more headroom and/or redesigned so that Soldiers are not elevated in the HMMWV seat. More adequate ways of attaching the pad to the seat and ways of increasing ventilation should be considered.

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## APPENDIX A

## REFERENCES

1. Department of the Army (2005). Preventive Medicine. Army Regulation 40-5, Washington DC: Headquarters, Department of the Army.

2. Hodge J.G. 2005. An enhanced approach to distinguishing public health practice and human subjects research. *Journal of Law, Medicine and Ethics,* Spring:2-19.

3. Liira J.P., Shannon H.S., Chambers L.W., and Haines T.A. 1996. Long-term back problems and physical work exposures in the 1990 Ontario Health Survey. *American Journal of Public Health,* 86:382-387.

4. Guo H.R., Tanaka S., Cameron L.L., Seligman P.J., Behrens V.J., Ger J., Wild D.K., and Putz-Anderson V. 1995. Back pain among workers in the United States: national estimates and workers at high risk *American Journal of Industrial Medicine,* 28:591-602.

5. Walsh K., Varnes N., Osmond C., Styles R., and Coggon D. 1989. Occupational causes of low back pain. *Scandinavian Journal of Work, Environment and Health,* 15:54-59.

6. Behrens V., Seligman P., Cameron L., Mathias T., and Fine L. 1994. The prevalence of back pain, hand dscomfort and dermatitis in the US working population. *American Journal of Public Health and the Nations Health,* 1780-1785

7. Cherkin D.C., Deyo R.A., Volinn E., and Loeser J.D. 1992. Use of International Classification of Diseases (ICD-9-CM) to identify hospitalizations for mechanical low back pain in administrative databases. *Spine,* 17:817-825.

8. Krause N., Rugulies R., Ragland D.R., and Syme S.L. 2004. Physical workload, ergonomic problems, and incidence of low back injury: A 7.5 year prospective study of San Franciso transit operators. *American Journal of Industrial Medicine,* 46:570-585.

9. Kahn H.A., and Sempos C.T. 1989. *Statistical Methods in Epidemiology.* New York: Oxford University Press.

10. Hildebrandt V.H. 1995. Back pain tn the working population: prevalence rates in Dutch trades and professions. *Ergonomics,* 38:1283-1298.

11. Bovenzi M., and Zadini A. 1992. Self-reported low back symptom in urban bus drivers exposed to whole body vibration. *Spine,* 17:1048-1059.

12. Luoma K., Riihimaki H., Raininko R., Luukkonen R., Lamminen A., and Viikari-Juntura E. 1998. Lumbar disc degeneration in relation to occupation. *Scandinavian Journal of Work, Environment and Health,* 24:358-366.

13. Krause N., Ragland D.R., Fischer J.M., and Leonard S.S. 1998. 1998 Volvo Award winner in clinical studies: psychosocial job factors, physical workload, and incidence of work-related spinal injury: a 5-year prospective study of urban transit operators. *Spine,* 23:2507-2516.

14. Heliovaara M. 1987. Occupational risk of hernated lumbar intervertebral disc or sciatica leading to hospitalization. *Journal of Chronic Diseases,* 40:259-264.

15. Costa G., Sartori P., Facco P., and Apostoli P. 2001. Health conditions of bus drivers in a 6 year follow-up study`. *Journal of Human Ergology,* 30:405-410.

16. Anderson R. 1992. The back pain of bus drivers. Prevalence in an urban area of California. *Spine,* 17:1481-1488.

17. Frymoyer J.W., Pope M.H., Costanza M.C., Rosen J.C., Goggin J.E., and Wilder D.G. 1980. Epidemiologic studies of low back pain. *Spine,* 5:419-423.

18. Netterstrom B., and Juel K. 1989. Low back trouble among urban bus drivers in Denmark. *Scandinavian Journal of Social Medicine,* 17:203-206.

19. Backman A.L. 1983. Health survey of professional drivers. *Scandinavian Journal of Work, Environment and Health,* 9:30-35.

20. Bovenzi M., and Betta A. 1994. Low-back disorders in argicultural tractor drivers exposed to whole body vibration and postural stress. *Applied Ergonomics,* 25:231-241.

21. Jin K., Sorock G.S., Courtney T., Liang Y., Yao X., Matz S., and Ge L. 2000. Risk factors for work-related low back pain in the People's Rebublic of China. *International Journal of Occupational and Environmental Health,* 6:26-33.

22. Magnusson M.L., Pope M.H., Wilder D.G., and Areskoug B. 1996. Are occupational divers at an increased risk for developing musculoskeletal disorders? *Spine,* 21:710-717.

23. Boshuizen H.C., Bongers P.M., and Hulshof C.T.J. 1990. Self-reported back pain in tractor drivers exposed to whole body vibration. *International Archives of Occupational and Environmental Health,* 62:109-115.

24. Videman T., Nurminen M., and Troup J.D.G. 1990. Lumbar spinal pathology in cadaveric material in relation to history of back pain, occupation, and physical loading. *Spine,* 15:728-740.

25. Pietri F., Lecleric A., Boitel L., Chastang J.F., Morcet J.F., and Blondet M. 1992. Low-back pain in commercial travelers. *Scandinavian Journal of Work, Environment and Health,* 18:52-58.

26. Okunribido O.O., Magnusson M., and Pope M.H. 2008. The role of whole body vibration, posture and manual material handling as risk factors for low back pain in occupational drivers. *Ergonomics,* 51:308-329.

27. Porter J.M., and Gyi D.E. 2002. The prevalence of musculoskeletal troubles among car drivers. *Occupational Medicine,* 52:4-12.

28. Tiemessen I.J.H., Hulshof C.T.J., and Frings-Dresen M.H.W. 2008. Low back pain in drivers exposed to whole body vibration: analysis of a dose-response pattern. *Occupational and Environmental Medicine,* 65:667-675.

29. Miyamoto M., Konno S., Gembun Y., Liu X., Minami K., and Ito H. 2008. Epidemiolohgical study of low back pain and occupational risk factors among taxi drivers. *Industrial Health,* 46:112-117.

30. Krause N., Ragland D.R., Greiner B.A., Fischer J.M., Holman B.L., and Selvin S. 1997. Physical workload and ergonomic factors associated with prevalence of back and neck pain in urban transit operators. *Spine,* 22:2117-2126.

31. Miyamoto M., Shirai Y., Gembun Y., and Kaneda K. 2000. An epidemiologic study of occupational low back pain in truck trivers. *Journal of Nippon Medical School,* 67:186-=190.

32. Chen J.C., Chang W.R., Chang W., and Christiani D. 2005. Occupational factors associated with low back pain in urban taxi drivers. *Occupational Medicine,* 55:535-540.

33. Andrusaitis S.F., Oliveira R.P., and Filho T.E.P.B. 2006. Study of the prevalence and risk factors for low back pain in truck drivers in the state of San Paulo, Brazil. *Clinics in Chest Medicine,* 61:503-510.

34. Robb M.J.M., and Mansfield N.J. 2007. Self-reported musculoskeletal problems amonst professional truck drivers. *Ergonomics,* 50:814-827.

35. Tamrin S.B.M., Yokoyama K., Jalaludin J., Aziz N.A., Jemoin N., Nordin T., Naing A.L., Abdullah Y., and Abdullah M. 2007. The association between risk factors and low back pain

among commerical vehiucle drivers in peninsular Malaysia: a preliminary result. *Industrial Health,* 45:268-278.

36. Anderson G.S. 1992. A comparison of predictive tests of aerobic capacity. *Canadian Journal of Sport Sciences,* 17:304-308.

37. Chen J.C., Dennerlein J.T., Chang C.C., Chang W.R., and Christiani D.C. 2005. Seat inclination, use of lumbar support and low back pain of taxi drivers. *Scandinavian Journal of Work, Environment and Health,* 31:258-265.

38. Bovenzi M. 2008. Metrics of whole body vibration and exposure-response relationship for low-back pain in professional drivers: a prospective cohort study. *International Archives of Occupational and Environmental Health,* In Press

39. Boshuizen H.C., Bongers P., and Hulfhof C.T.J. 1992. Self-reported back pain in fork-lift truck and fraight container tractor drivers exposed to whole-body vibration. *Spine,* 17:59-65.

40. Burton A.K., Tillotson K.M., Symonds T.L., Burke C., and Mathewson T. 1996. Occupational risk factors for the first onset and subsequent course of low back trouble. *Spine,* 21:2612-2620.

41. Schwarze S., Notbohm G., Dupuis H., and Hartung E. 1998. Dose-response relationship between whole-body vibration and lumbar disk disease-a field study on 388 drivers of different vehicles. *Journal of Sound and Vibration,* 215:613-628.

42. Canadian Centre for Occupational Health and Safety (2008). Vibration-Introduction. On line at: http://www.ccohs.ca/oshanswers/phys_agents/vibration/vibration_intro.html, Accessed

43. Wilder D.G., Pope M.H., and Magnusson M. 1996. Mechanical stress reduction during seated jolt/vibration exp[osure. *Seminars in Perinatology,* 20:54-60.

44. Wilder D.G., Woodworth B.B., Frymoyer J.W., and Pope M.H. 1982. Vibration and the human spine. *Spine,* 7:243-254.

45. Okunribido O.O., Shimbles S.J., Magnusson M., and Pope M. 2007. City bus driving and low back pain: a study of the exposures to posture demands, manual materials handling and whole body vibration *Applied Ergonomics,* 38:29-38.

46. Hampel G.A., and Chang W.R. 1999. Body height changes from motor vehicle vibration. *International Journal of Industrial Ergonomics,* 23:489-498.

47. Funakoshi M., Taoda K., Tsujimura H., and Nishiyama K. 2004. Measurement of whole body vibration in taxi drivers. *Journal of Occupational Health,* 46:119-124.

48. Kumar S. 2004. Vibration in operating heavy haul trucks in overburden mining. *Applied Ergonomics,* 35:509-520.

49. Johanning E., Wilder D.G., Landrigan P.J., and Pope M.H. 1991. Whole body vibration exposure in ubway cars and review of adverse health effects. *Journal of Occupational Medicine,* 33:605-612.

50. Cann A.P., Salmoni A.W., and Eger T.R. 2004. Predictors of whole-body vibration experienced by highway transport turck operators. *Ergonomics,* 47:1432-1453.

51. Pope M.H., Magnusson M., and Wilder D.G. 1998. Kappa Delta Award. Low back pain and whole body vibration. *Clinical Orthopaedics and Related Research,* 354:241-248.

52. Panjabi M.M., Andersson G.B.J., Jorneus L., Hult E., and Mattsson L. 1986. In vivo measurement of spinal column vibramtions. *Journal of Bone and Joint Surgery,* 68A:695-702.

53. Sandover J., and Dupuis H. 1987. A reanalysis of spinal motion during vibration. *Ergonomics,* 30:975-985.

54. Seroussi R.E., Wilder D.G., and Pope M.H. 1989. Trunk muscle electromyography and whole body vibration. *Journal of Biomechanics,* 22:219-229.

55. Seidel H., Bastek R., BraHer D., Buchholz C., Meister A., Metz A.M., and Rothe R. 1980. On human response to prolonged repeated whole-body vibration. *Ergonomics,* 23:191-211.

56. Hansson T., Magnusson M., and Broman H. 1991. Back muscle fatigue and seated whole body vibration: an experimental study in man. *Clinical Biomechanics,* 6:173-178.

57. Komi P.V., and Tesch P. 1979. EMG frequency spectrum, muscle structure, and fatigue during dynamic contractions in man. *European Journal of Applied Physiology and Occupational Physiology,* 42:41-50.

58. Moritani T., Nagata A., and Muro M. 1982. Electromyographic manifestation of muscular fatigue. *Medicine and Science in Sports and Exercise,* 14:198-202.

59. Wilder D., Magnusson M.L., Fenwick J., and Pope M. 1994. The effect of posture and seat suspension design on discomfort and back muscle fatigue during simulated truck driving. *Applied Ergonomics,* 25:66-76.

60. Magnusson M., Almqvist M., Broman H., Pope M., and Hansson T. 1992. Measurement of height loss during whole body vibration. *Journal of Spinal Disorders,* 5:198-203.

61. Hosea T.M., Simon S.R., Delatizky J., Wong M.A., and Hsieh C.C. 1986. Myographic analysis of the paraspinal musculature in relation to automobile driving. *Spine,* 11:928-936.

62. Dupuis H., Hartung E., and Haverkamp M. 1991. Acute effects of transient vertical whole-body vibration. *International Archives of Occupational and Environmental Health,* 63:261-265.

63. Solomonow M., Zhou B.H., Baratta R.V., Lu Y., and Harris M. 1999. Biomechanics of increased exposure to lumbar injury caused by cyclic loading: Part 1. Loss of reflexive muscular stabilization. *Spine,* 24:2426-2434.

64. Lu D., Le P., Davidson B., Zhou B.H., Lu Y., Patel V., and Solomonow M. 2008. Frequency of cyclic lumbar loading is a risk factor for cumulative trauma disorder. *Muscle and Nerve,* 38:867-874.

65. Solomonow M., Baratta R.V., Zhou B.H., Burger E., Zieske A., and Gedalia A. 2003. Muscular disfunction elicted by creep of lumbar viscoelastic tissue *Journal of Electromyography and Kinesiology,* 13:381-396.

66. Ekstrom I., Kaigle A., Holm S., Rostedt M., and Hansson T. 1996. Intervertebral disc response to cyclic loading-an animal model. *Proceedings of the Institution of Mechanical Engineers. Part H, Journal of Engineering in Medicine,* 210:249-258.

67. Bonney R. 1988. Some effects on the spine from driving. *Clinical Biomechanics,* 3:236-240.

68. Maikala R.V., King S., and Bhambhani Y.N. 2006. Acute physiological responses in healthy men during whole body vibration. *International Archives of Occupational and Environmental Health,* 79:103-114.

69. Hulshof C.T.J., and Zanten B.V.v. 1987. Whole-body vibration and low-back pain. A review of epidemiologic studies. *International Archives of Occupational and Environmental Health,* 59:205-220.

70. Bovenzi M., and Hulshof C.T.J. 1999. An updated review of epidemiological studies on the relationship between exposure to whole-body vibration and low back pain. *International Archives of Occupational and Environmental Health,* 72:351-365.

71. Lings S., and Leboeuf-Yde C. 2000. Whole body vibration and low back pain: asystematic critical review of the epidemiological literature 1992-1999. *International Archives of Occupational and Environmental Health,* 73:290-297.

72. Hartvigsen J., Leboeuf-Yde C., Lings S., and Corder E.H. 2000. Is sitting-while-at-work associated with low back pain? A systematic, critical literature review. *Scandinavian Journal of Public Health,* 28:230-239.

73. Corlett E.N., and Eklund J.A. 1984. How does a backrest work? *Applied Ergonomics,* 15

74. Carcone S.M., and Keir P.J. 2007. Effects of backrest design on biomechanics and comfort during seated work. *Applied Ergonomics,* 38:755-764.

75. Andersson G.B.J., Murphy R.W., Ortengren R., and Nachemson A.L. 1979. The influence of backrest inclination and lumbar support on lumbar lordosis. *Spine,* 4:52-58.

76. Bendix T., Poulsen V., Klausen K., and Jensen C.V. 1996. What does a backrest actually do to the lumbar spine? *Ergonomics,* 39:533-542.

77. Majeske C., and Buchanan C. 1984. Quantitative description of two sitting postures with and without lumbar support pillow. *Physical Therapy,* 10:1531-1533.

78. Williams M.M., Hawley J.A., McKenzie R.A., and vanWijmen P.M. 1991. A comparison of the effects of two sitting postures on back and reffed pain. *Spine,* 16:1185-1191.

79. Anderson B.J.G., Ortensen R., Nachemson A., and Elfstron G. 1974. Lumbar disc pressures and myoelectric activity during sitting. IV. Studies on a car driver's seat. *Scandinavian Journal of Rehabilitation Medicine,* 6:128-133.

80. Magnusson M., Pope M., Rostedt M., and Hansson T. 1993. Effect of backrest inclination on the transmission of vertical vibrations through the lumbar spine. *Clinical Biomechanics,* 8:5-12.

81. Makhsous M., Hendrix R., Crowther Z., Nam E., and Lin F. 2005. Reducing whole body vibrition and musaculoskeletal injury with a new car seat design. *Ergonomics,* 48:1183-1199.

82. Lin F., Crowther Z., and Makhsous M. Reducing whole body vibration of vehicle drivers with a new seating concept. *In Proceedings of Conference Proceedings IEEE Engineering in Medicine and Biology Society.* San Franciso CA, 2004.

83. Wijaya A.R., Jonsson P., and Johansson O. 2003. The effects of seat design on vibration comfort. *International Journal of Occupational Safety and Ergonomics,* 9:193-210.

84. Johnson D.A., and Neve M. 2001. Analysis of possible lower lumbar strains caused by the structural properities of automobile seats: a review of some recnt technical literature. *Journal of Manipulative and Physiological Therapeutics,* 24:582-588.

85. Sprigle S., Chung K.C., and Brubaker C.E. 1990. Reduction of seating pressures with custom contoured cushions. *Journal of Rehabilitation Research and Development,* 27:135-140.

86. Porter J.M., Gyi D.E., and Tait H.A. 2003. Interface pressure data and the prediction of driver discomfort in road trials. *Applied Ergonomics,* 34:207-214.

87. Gyi D.E., and Porter J.M. 1999. Interface pressure and the prediction of car seat discomfort. *Applied Ergonomics,* 30:99-107.

88. Ebe K., and Griffin M.J. 2001. Factors affecting static seat cushion comfort. *Ergonomics,* 44:901-921.

89. Ebe K., and Griffin M.J. 2000. Quantative prediction of overall seat discomfort *Ergonomics,* 43:791-806.

90. Ebe K., and Griffin M.J. 2000. Quantative models of seat discomfort including static and dynamic factors. *Ergonomics,* 43:771-790.

91. Butler B.P., and Alem N.M. (1994). Apache helicopter seat cushion evaluation. Technical Report No. 94-32, Fort Rucker, AL: US Army Aeromedical Research Laboratory.

92. Pope M.H., Broman H., and Hanson T. 1989. The dynamic response of a subjecyt seated on various cushions. *Ergonomics,* 32:1155-1166.

93. Huston D.R., Johnson C.C., Wood M.A., and Zhao X. 1999. Vibration attenuating characteristics of air filled seat cushions. *Journal of Sound and Vibration,* 222:333-340.

94. Skydex (2009). Reducing mid and lower back injuries in tactical vehicles. White Paper. Centennial CO: Skydex Technologies, Inc.

95. Knapik J.J., Burse R.L., and Vogel J.A. 1983. Height, weight, percent body fat and indices of adiposity for young men and women entering the U.S. Army. *Aviation, Space and Environmental Medicine,* 54:223-231.

96. Hosmer D.W., and Lemeshow S. 1989. *Applied Logistic Regression.* New York: John Wiley & Sons.

97. Cheung K., Hume P., and Maxwell L. 2003. Delayed onset muscle soreness: treatment strategies and performance factors. *Sports Medicine,* 33:145-164.

98. Dasinger L.K., Krause N., Deegan L.J., Brand R.J., and Rudolph L. 2000. Physical workplace factors and return to work after compensated low back injury: a disability phase-specific analysis. *Journal of Occupational Medicine,* 42:323-333.

# APPENDIX B

## REQUEST LETTER

DEPARTMENT OF THE ARMY
1ST SUSTAINMENT COMMAND (THEATER)
CAMP ARIFJAN, KUWAIT
APO AE 09366

REPLY TO
ATTENTION OF:

ACEN-TSC-DCG

20 August 2008

MEMORANDUM FOR Commander, USACHPPM, ATTN: MCHB-TS-OER (Callison)
5158 Blackhawk Road Army Proving Ground, MD 21010-5403

SUBJECT: Invitation to US Army Center for Health Promotion and Preventive Medicine (USACHPPM)

1. Purpose of the visit: To permit USACHPPM to evaluate vibration, postural, and injury outcomes measurements which are part of a Deployments and Operations Task Force proof-of-concept project for reducing mid and lower back injuries caused when using SKYDEX seat products. Studies should be conducted in Kuwait in order to replicate unique field terrain, mission, personnel and vehicle configurations.

2. Recommended Attendees:
LTC Myrna Callison, USACHPPM
Mr. Steven Chervak, GS-13 USACHPPM
Dr. Joseph Knapik GS-14, USACHPPM
Mr. John Petty, ATC GS-13, (Aberdeen Test Command)

3. SKYDEX corporation has developed a twin-hemisphere geometry shock and impact attenuation material. This technology may mitigate "whole body vibration" (WBV) in military vehicles. USACHPPM has worked with SKYDEX and assisted them in developing their proprietary technology into a "wedge seat" design that would also address problems with seat posture. 1st TSC in the Kuwait AOR has evaluated some other commercially available seat wedges and found only minimal user comfort. Anecdotally, there were user needs expressed that appear to be met by the SKYDEX product.

4. Point of contact is COL Helen D. Meelheim, 1st TSC Command Surgeon.

H. GARY BUNCH
Brigadier General, US Army
Deputy Commanding General

# APPENDIX C.

## ICD-9 CODES ASSOCIATED WITH LOW BACK PAIN

These are ICD-9 codes that are definitely or possibility associated with low back problems. The codes are those developed by Cherkin et al.[7] with modifications by Krause et al.[8]. An additional code for spinal stress fractures is included. These codes involve conditions originating in the lumbosacral spine assumed to be due to overuse or acute conditions that are not associated with neoplastic conditions, infections, or pregnancy. Severity rankings are based on clinical judgment[8] and have been shown to be associated with duration of work disability[98].

| Code Grouping Name (Index) ICD-9 Code | Description of ICD-9 Code | Type[a] | Severity[b] | Severity Group[c] |
|---|---|---|---|---|
| Herniated Disc Index | | | | |
| 722.1 | Displacement of thoracic or lumbar intervertebral disc w/o myelopathy | P | 4 | 2 |
| 722.10 | Displacement of lumbar intervertebral disc w/o myelopathy | D | 4 | 2 |
| 722.2 | Displacement of intervertebral disc, site unspecified, w/o myelopathy | P | 4 | 2 |
| 722.70 | Intervertebral disc disorder w/myelopathy, unspecified region | P | 3 | 1 |
| 722.73 | Intervertebral disc disorder w/myelopathy, lumbar region | D | 3 | 1 |
| Probable Degenerative Index | | | | |
| 720.1 | Spinal enthesopathy | P | 7 | 3 |
| 720.2 | Sacroiliitis, not elsewhere classified | P | 7 | 3 |
| 721.3 | Lumbosacral spondylosis w/o myelopathy | D | 7 | 3 |
| 721.5 | Kissing spine | P | 7 | 3 |
| 721.6 | Ankylosing vertebral hyperostosis | P | 7 | 3 |
| 721.7 | Traumatic spondylopathy | P | 7 | 3 |
| 721.8 | Other allied disorders of spine | P | 7 | 3 |
| 721.9 | Spondylosis of unspecified site | P | 7 | 3 |
| 722.52 | Lumbar or lumbosacral intervertebral disc disorder | D | 7 | 3 |
| 722.6 | Degeneration of intervertebral disc, site unspecified | P | 7 | 3 |
| 722.90 | Other and unspecified disc disorder | P | 7 | 3 |
| 722.93 | Other and unspecified disc disorder, lumbar region | D | 7 | 3 |
| Spinal Stenosis Index | | | | |
| 721.42 | Lumbar spondylosis w/myelopathy | D | 2 | 1 |
| 721.91 | Spondylosis of unspecified site w/melopathy | P | 2 | 1 |
| 724.00 | Spinal stenosis, unspecified region | P | 2 | 1 |
| 724.02 | Spinal stenosis, lumbar region | D | 2 | 1 |
| 724.09 | Spinal stenosis, region other than lumbar or thoracic | P | 2 | 1 |
| Radiating Back Pain Index | | | | |
| 724.3 | Sciatia | D | 5 | 2 |
| Possible Instability Index | | | | |

| Code Grouping Name (Index) ICD-9 Code | Description of ICD-9 Code | Type[a] | Severity[b] | Severity Group[c] |
|---|---|---|---|---|
| 724.6 | Disorders of sacrum | D | 6 | 2 |
| 738.4 | Acquired spondylolisthesis | P | 6 | 2 |
| 756.11 | Spondylolysis, lumbosacral region | D | 6 | 2 |
| 756.12 | Spondylolisthesis | P | 6 | 2 |
| Nonspecific Backache Index | | | | |
| 307.89 | Pain disorders related to psychological factors, other | P | 8 | 3 |
| 724.2 | Lumbago | D | 8 | 3 |
| 724.5 | Backache, unspecified | P | 8 | 3 |
| 846.0 | Sprains and strains of lumbosacral (joint) (ligament) | D | 8 | 3 |
| 846.1 | Sprains and strains of sacroiliac ligament | D | 8 | 3 |
| 846.2 | Sprains and strains of sacrospinatus (ligament) | D | 8 | 3 |
| 846.3 | Sprains and strains of sacrotuberous (ligament) | D | 8 | 3 |
| 846.8 | Sprains and strains of sacrotuberous (ligament) | D | 8 | 3 |
| 846.9 | Sprains and strains of unspecified site of sacroiliac region | D | 8 | 3 |
| 847.1 | Sprains and strains of thoracic | D | 8 | 3 |
| 847.2 | Sprains and strains of lumbar | D | 8 | 3 |
| 847.3 | Sprains and strains of sacrum | D | 8 | 3 |
| 847.9 | Sprains and strains of unspecified site of back | P | 8 | 3 |
| Sequelae of Previous Back Surgery Index | | | | |
| 722.80 | Postlaminectomy syndrome, unspecified region | P | 1 | 1 |
| 722.83 | Postlaminectomy syndrome, lumbar region | D | 1 | 1 |
| 737.12 | Kyphosis, postlaminectomy | P | 2 | 1 |
| 737.21 | Lordosis, postlaminectomy | D | 2 | 1 |
| 996.4 | Mechanical complication of internal orthopedic device, implant, and graft | P | 1 | 1 |
| Fracture Index (closed, no spinal cord involvement) | | | | |
| 805.4 | Fracture, lumbar, closed | D | | |
| 805.6 | Fracture, sacrum and coccyx, closed | D | | |
| 805.8 | Fracture, unspecified, closed | D | | |
| Stress Fracture Index | | | | |
| 733.13 | Pathologic fracture of vertebrae | D | | |
| Miscellaneous Back Problems Index | | | | |
| 722.30 | Intervertebral disc disorders, unspecified region | P | 9 | 3 |
| 722.32 | Intervertebral disc disorders, lumbar region | D | 9 | 3 |
| 724.4 | Thoracic or lumbosacral neuritis or radiculitis, unspecified | P | 5 | 2 |
| 724.8 | Other symptoms referable to back | P | 9 | 3 |
| 724.9 | Other unspecified back disorders | P | 9 | 3 |
| 737.10 | Kyphosis (acquired) (postural) | P | 9 | 3 |
| 737.20 | Lordosis (acquired) (postural) | D | 9 | 3 |
| 737.30 | Scoliosis [and kyphoscoliosis], idiopathic | P | 9 | 3 |
| 737.31 | Resolving infantile idiopathic scoliosis | P | 9 | 3 |
| 737.32 | Progressive infantile idiopathic scoliosis | P | 9 | 3 |
| 737.33 | Scoliosis due to radiation | P | 9 | 3 |

| Code Grouping Name (Index) ICD-9 Code | Description of ICD-9 Code | Type[a] | Severity[b] | Severity Group[c] |
|---|---|---|---|---|
| 737.34 | Thoracogenic scoliosis | P | 9 | 3 |
| 737.39 | Kyphoscoliosis and scoliosis, other | P | 9 | 3 |
| 737.40 | Curvature of spine, unspecified | P | 9 | 3 |
| 737.41 | Kyphosis | P | 9 | 3 |
| 737.42 | Lordosis | D | 9 | 3 |
| 737.43 | Scoliosis | P | 9 | 3 |
| 737.8 | Other curvatures of spine | P | 9 | 3 |
| 737.9 | Unspecified curvature of spine | P | 9 | 3 |
| 738.5 | Other acquired deformity of back or spine | P | 9 | 3 |
| 739.3 | Nonallopathic lesions, not elsewhere classified, lumbar region | D | 8 | 3 |
| 739.4 | Nonallopathic lesions, not elsewhere classified, sacral region | D | 8 | 3 |
| 741.3 | Spina bifida, lumbar region | D | 9 | 3 |
| 756.10 | Anomaly of spine, unspecified | P | 9 | 3 |
| 756.11 | Spondylolysis, lumbosacral region | P | 9 | 3 |
| 756.12 | Spondylolisthesis | P | 9 | 3 |
| 756.13 | Absence of vertebra, congenital | P | 9 | 3 |
| 756.14 | Hemivertebra | P | 9 | 3 |
| 756.15 | Fusion of spine [vertebra], congenital | P | 9 | 3 |
| 756.16 | Klippel-Feil syndrome | P | 9 | 3 |
| 756.17 | Spina bifida occulta | P | 9 | 3 |
| 756.19 | Anomaly of spine, other | P | 9 | 3 |
| All Back Problem Index (all codes above excluding frank fractures) | | | | |
| 307.89 | Pain disorders related to psychological factors, other | P | 8 | 3 |
| 720.1 | Spinal enthesopathy | P | 7 | 3 |
| 720.2 | Sacroiliitis, not elsewhere classified | P | 7 | 3 |
| 721.3 | Lumbosacral spondylosis w/o myelopathy | D | 7 | 3 |
| 721.42 | Lumbar spondylosis w/myelopathy | D | 2 | 1 |
| 721.5 | Kissing spine | P | 7 | 3 |
| 721.6 | Ankylosing vertebral hyperostosis | P | 7 | 3 |
| 721.7 | Traumatic spondylopathy | P | 7 | 3 |
| 721.8 | Other allied disorders of spine | P | 7 | 3 |
| 721.9 | Spondylosis of unspecified site | P | 7 | 3 |
| 721.91 | Spondylosis of unspecified site w/melopathy | P | 2 | 1 |
| 722.1 | Displacement of thoracic or lumbar intervertebral disc w/o myelopathy | P | 4 | 2 |
| 722.10 | Displacement of lumbar intervertebral disc w/o myelopathy | D | 4 | 2 |
| 722.2 | Displacement of intervertebral disc, site unspecified, w/o myelopathy | P | 4 | 2 |
| 722.30 | Intervertebral disc disorders, unspecified region | P | 9 | 3 |
| 722.32 | Intervertebral disc disorders, lumbar region | D | 9 | 3 |
| 722.52 | Lumbar or lumbosacral intervertebral disc disorder | D | 7 | 3 |
| 722.6 | Degeneration of intervertebral disc, site unspecified | P | 7 | 3 |
| 722.70 | Intervertebral disc disorder w/myelopathy, unspecified region | P | 3 | 1 |
| 722.73 | Intervertebral disc disorder w/myelopathy, lumbar region | D | 3 | 1 |
| 722.80 | Postlaminectomy syndrome, unspecified region | P | 1 | 1 |
| 722.83 | Postlaminectomy syndrome, lumbar region | D | 1 | 1 |
| 722.90 | Other and unspecified disc disorder | P | 7 | 3 |

| Code Grouping Name (Index) ICD-9 Code | Description of ICD-9 Code | Type[a] | Severity[b] | Severity Group[c] |
|---|---|---|---|---|
| 722.93 | Other and unspecified disc disorder, lumbar region | D | 7 | 3 |
| 724.00 | Spinal stenosis, unspecified region | P | 2 | 1 |
| 724.02 | Spinal stenosis, lumbar region | D | 2 | 1 |
| 724.09 | Spinal stenosis, region other than lumbar or thoracic | P | 2 | 1 |
| 724.2 | Lumbago | D | 8 | 3 |
| 724.3 | Sciatia | D | 5 | 2 |
| 724.4 | Thoracic or lumbosacral neuritis or radiculitis, unspecified | P | 5 | 2 |
| 724.5 | Backache, unspecified | P | 8 | 3 |
| 724.6 | Disorders of sacrum | D | 6 | 2 |
| 724.8 | Other symptoms referable to back | P | 9 | 3 |
| 724.9 | Other unspecified back disorders | P | 9 | 3 |
| 733.13 | Pathologic fracture of vertebrae | D | | |
| 737.10 | Kyphosis (acquired) (postural) | P | 9 | 3 |
| 737.12 | Kyphosis, postlaminectomy | P | 2 | 1 |
| 737.21 | Lordosis, postlaminectomy | D | 2 | 1 |
| 737.20 | Lordosis (acquired) (postural) | D | 9 | 3 |
| 737.30 | Scoliosis [and kyphoscoliosis], idiopathic | P | 9 | 3 |
| 737.31 | Resolving infantile idiopathic scoliosis | P | 9 | 3 |
| 737.32 | Progressive infantile idiopathic scoliosis | P | 9 | 3 |
| 737.33 | Scoliosis due to radiation | P | 9 | 3 |
| 737.34 | Thoracogenic scoliosis | P | 9 | 3 |
| 737.39 | Kyphoscoliosis and scoliosis, other | P | 9 | 3 |
| 737.40 | Curvature of spine, unspecified | P | 9 | 3 |
| 737.41 | Kyphosis | P | 9 | 3 |
| 737.42 | Lordosis | D | 9 | 3 |
| 737.43 | Scoliosis | P | 9 | 3 |
| 737.8 | Other curvatures of spine | P | 9 | 3 |
| 737.9 | Unspecified curvature of spine | P | 9 | 3 |
| 738.4 | Acquired spondylolisthesis | P | 6 | 2 |
| 738.5 | Other acquired deformity of back or spine | P | 9 | 3 |
| 739.3 | Nonallopathic lesions, not elsewhere classified, lumbar region | D | 8 | 3 |
| 739.4 | Nonallopathic lesions, not elsewhere classified, sacral region | D | 8 | 3 |
| 741.3 | Spina bifida, lumbar region | D | 9 | 3 |
| 756.10 | Anomaly of spine, unspecified | P | 9 | 3 |
| 756.11 | Spondylolysis, lumbosacral region | P | 9 | 3 |
| 756.12 | Spondylolisthesis | P | 9 | 3 |
| 756.13 | Absence of vertebra, congenital | P | 9 | 3 |
| 756.14 | Hemivertebra | P | 9 | 3 |
| 756.15 | Fusion of spine [vertebra], congenital | P | 9 | 3 |
| 756.16 | Klippel-Feil syndrome | P | 9 | 3 |
| 756.17 | Spina bifida occulta | P | 9 | 3 |
| 756.19 | Anomaly of spine, other | P | 9 | 3 |
| 846.0 | Sprains and strains of lumbosacral (joint) (ligament) | D | 8 | 3 |
| 846.1 | Sprains and strains of sacroiliac ligament | D | 8 | 3 |
| 846.2 | Sprains and strains of sacrospinatus (ligament) | D | 8 | 3 |
| 846.3 | Sprains and strains of sacrotuberous (ligament) | D | 8 | 3 |
| 846.8 | Sprains and strains of sacrotuberous (ligament) | D | 8 | 3 |
| 846.9 | Sprains and strains of unspecified site of sacroiliac region | D | 8 | 3 |

| Code Grouping Name (Index) ICD-9 Code | Description of ICD-9 Code | Type[a] | Severity[b] | Severity Group[c] |
|---|---|---|---|---|
| 847.1 | Sprains and strains of thoracic | D | 8 | 3 |
| 847.2 | Sprains and strains of lumbar | D | 8 | 3 |
| 847.3 | Sprains and strains of sacrum | D | 8 | 3 |
| 847.9 | Sprains and strains of unspecified site of back | P | 8 | 3 |
| 996.4 | Mechanical complication of internal orthopedic device, implant, and graft | P | 1 | 1 |

[a]Type: P=Possible low back; D=Definite low back

[b]Severity (1=most, 8=least): 1=postlaminactomy syndrome; 2=spinal stenosis; 3=herniated disc with myelopathy; 4=herniated disc without myelopathy; 5=sciatica; 6=possible instability; 7=probably degenerative changes; 8=nonspecific backache

[c]Severity Group (1=high, 3=low): 1=highest (severity1-3); 2=middle (severity 4-6); 3=lowest (severity 7-9)

# APPENDIX D.
# BACKGROUND QUESTIONNAIRE (Example)

In this questionnaire you will be asked about yourself, your lifestyle, past injuries, and your work and deployment history. Please answer each question to the best of your ability.

1. Name: _____ 2. SSN: _____
*(Last, First, Middle)*

3. Today's Date: ____/____/____
*month/day/year (e.g., 1/3/07)*

4. Date of Birth: ____/____/____
*month/day/year (e.g., 4/11/83)*

5. Gender: ☐ 0 Male ☐ 1 Female

6. Height: |____| feet |____| inches

7. Weight: |_____| pounds

8. When did you arrive in Kuwait for this current deployment ____/____/____
*month/day/year (e.g. 3/12/08)*

**PHYSICAL ACTIVITY**

9. Compared with others your same age and sex in the Army, how would you rate yourself as to the amount of physical activity you perform?

☐ 1 Much less active ☐ 2 Somewhat less active ☐ 3 About the same ☐ 4 Somewhat more active ☐ 5 Much more active

10. Over the last two months, what was the average number of times per week you exercised or played sports for at least
30 minutes at a time?

☐ 0 Never
☐ 1 Less than 1 time per week
☐ 2 1 time per week
☐ 3 2 times per week
☐ 4 3 times per week
☐ 5 4 times per week
☐ 6 5 times per week
☐ 7 6 times per week
☐ 8 7 times or more per week

**PHYSICAL FITNESS**

11. What was the month and year of your last Army Physical Fitness Test (APFT)? ____/____
*month/year (e.g. 11/07)*

12. What were the raw scores on your last APFT (to the best of your memory)?

a. Push-Ups |____| reps
b. Sit-Ups |_____| reps
c. 2-Mile Run |___|____| min: sec
d. Alternate Test _____ (list) Raw Score |_____|

**TOBACCO USE**

13. During the past 30 days, on how many days did you smoke a cigarette?
*(If you have never smoked or not smoked in the last 30 days, write 0)* |____| days

14. During the past 30 days, on the days you smoked, how many cigarettes did you smoke per day?
*(If you have never smoked or not smoked in the last 30 days, write 0)*

|____| cigarettes

15. If you smoked cigarettes but quit, how many months or years ago did you quit?
*(If you have never smoked, write 00)*

|____| months

|____| years

16. During the past 30 days, on how many days did you use smokeless tobacco (chewing, snuffing, pinching, etc)?
*(If you have never used smokeless tobacco or not used any in the last 30 days, write 0)*

|____| days

17. During the past 30 days, on the days you used smokeless tobacco, how many cans, pouches or plugs did you use per day?
*(If you have never used smokeless tobacco or not used it in the last 30 days, write 0)*

|____| cans, pouches, or plugs

## RECENT INJURY

18. Within the last six months did you have an injury? ☐ 0 No ☐ 1 Yes If yes, please indicate the body area involved, the type of injury, the cause of the injury, and the number of limited duty days, if any. If no, go to the next page and continue with Question 20.

**INJURY (Most Serious Injury in Last 6 Months)**

**a. Body Area of Injury** *(select one)*

- ☐ Head
- ☐ Face
- ☐ Ear
- ☐ Eye
- ☐ Neck
- ☐ Chest
- ☐ Abdomen
- ☐ Upper Back
- ☐ Lower Back
- ☐ Shoulders
- ☐ Elbow
- ☐ Upper Arm
- ☐ Lower Arm
- ☐ Wrist
- ☐ Hand
- ☐ Finger
- ☐ Hip
- ☐ Thigh
- ☐ Knee
- ☐ Calf/Shin
- ☐ Ankle
- ☐ Foot
- ☐ Toe
- ☐ Other *(list below)*

_____

_____

**b. Type of Injury** *(select one)*

- ☐ Dislocation
- ☐ Fracture
- ☐ Blister
- ☐ Abrasion
- ☐ Cut (Laceration)
- ☐ Bruise
- ☐ Stress Fracture
- ☐ Tendonitis
- ☐ Bursitis
- ☐ Fasciitis
- ☐ Strain
- ☐ Sprain
- ☐ Heat Injury
- ☐ Cold Injury
- ☐ Insect or Animal Bite
- ☐ Joint Pain
- ☐ Pinched Nerve
- ☐ Other *(list below)*

_____

_____

**c. Cause of Injury** *(select one)*

- ☐ Physical Training (PT)
- ☐ APFT
- ☐ Sports during PT
- ☐ Sports (other)
- ☐ Military Vehicle Accident
- ☐ POV Accident
- ☐ Road Marching
- ☐ Field Training
- ☐ Airborne Jump
- ☐ Garrison or Home Activity
- ☐ Horseplay/Fighting
- ☐ Ice
- ☐ Chronic (Recurrent) Condition
- ☐ Other *(list below)*

_____

_____

d. Total days of limited duty for injury described above *(if none, write 0)* |___| days

e. Did you go to a medical facility, battalion aid station, or see a doctor or other health care provider for this injury?
☐ 0 No ☐ 1 Yes

19. Did you have more than one injury in the last 6 months? ☐ 0 No ☐ 1 Yes

## LOW BACK PAIN

20. **LOW BACK PAIN:** Please answer the following questions regarding low back pain you have experienced **in the last 7 days and last 6 months.**

| | **During the last 7 days** | **During the past 6 months** |
|---|---|---|
| a. Did you have aches, pain, discomfort or other symptoms with your low back? | ☐ 0 Never<br>☐ 1 Seldom<br>☐ 2 Often | ☐ 0 Never *(Go to Question 21)*<br>☐ 1 Seldom<br>☐ 2 Often |
| b. Was your back trouble: | ☐ 3 Constant<br>☐ 2 Comes and goes (episodic)<br>☐ 1 Only happened once | ☐ 3 Constant<br>☐ 2 Comes and goes (episodic)<br>☐ 1 Only happened once |
| c. How many episodes did you have with your low back trouble? | \|____\| Episodes in last 7 days | \|____\| Episodes in last 6 months |
| d. How many days did your low back trouble typically last? | \|____\| Days in last 7 days | \|____\| Days in last 6 months |
| e. How many days of profile were you given for your low back problem? | ☐ 0 None<br>\|____\| Profile days in last 7 days | ☐ 0 None<br>\|____\| Profile days in last 6 months |
| f. Where was the low back trouble? | ☐ 1 Low back only<br>☐ 2 Low back and buttocks<br>☐ 3 Low back, buttocks and legs<br>☐ 4 Low back and other _____ | ☐ 1 Low back only<br>☐ 2 Low back and buttocks<br>☐ 3 Low back, buttocks and legs<br>☐ 4 Low back and other _____ |
| g. Was there any movement that **caused** your low back trouble? | ☐ 0 No ☐ 1 Yes<br>If yes, what movement?<br>_____ | ☐ 0 No ☐ 1 Yes<br>If yes, what movement?<br>_____ |
| h. Was there any movement that **aggravated** your low back trouble? | ☐ 0 No ☐ 1 Yes<br>If yes, what movement?<br>_____ | ☐ 0 No ☐ 1 Yes<br>If yes, what movement?<br>_____ |

How would you rate the severity of this low back trouble during the following activities?

*(0=no trouble, 1= very low severity, 10=highest severity)*

| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| i. driving | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| j. lifting | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| k. walking | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| l. standing | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| m. sitting | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| n. sleeping | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

21. Have you ever had low back pain at **any** time in your life? ☐ 0 No ☐ 1 Yes

**WORK HISTORY**

22. Prior to joining the military, what were your previous occupation(s)?

_____
For how many years |____|

_____
For how many years |____|

_____
For how many years |____|

23. When did you **complete** Basic Combat Training? ____/____
*month/year (e.g. 9/05)*

24. What is your current military occupational specialty (MOS)? |____| *(MOS number, for example 88M)*

25. How long have you been in this MOS? |____| months |____| years

26. Are you currently working outside your MOS? ☐ 0 No ☐ 1 Yes. If yes, what duties are you currently performing?

_____

27. Are you: ☐ 1 Active Army ☐ 2 Army Reserve ☐ 3 National Guard ☐ 4 Other

If Guard or Reserve, what is your occupation outside the Army? _____

28. PRIOR to your current deployment, list the information below for each vehicle you drove for work. Vehicles might include HMMWVs, HETTs, cars, buses, trucks, forklifts, heavy machinery, and the like. Rate the comfort of the seats in these vehicles. *(If you did not drive, leave blank.)*

| | Type | Hours per run | Runs per month | Miles per run | Seat Comfort Rating *(1=low comfort, 5=high comfort)* 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle 1 | _____ | \|___\| | \|___\| | \|___\| | ☐ | ☐ | ☐ | ☐ | ☐ |
| Vehicle 2 | _____ | \|___\| | \|___\| | \|___\| | ☐ | ☐ | ☐ | ☐ | ☐ |
| Vehicle 3 | _____ | \|___\| | \|___\| | \|___\| | ☐ | ☐ | ☐ | ☐ | ☐ |

29. Prior to your current deployment, did you experience discomfort due to road vibration/jolts in your work? ☐ 0 No ☐ 1 Yes

30. Prior to your current deployment, did your work require you to lift with your hands? ☐ 0 No ☐ 1 Yes
How many times/week and how much weight?

\|___\| times/week lifted 10 lbs or less
\|___\| times/week lifted 11–50 lbs
\|___\| times/week lifted 51–100 lbs
\|___\| times/week lifted more than 100 lbs

31. Prior to your current deployment, did your job require you to push or pull loads? ☐ 0 No ☐ 1 Yes
How many times/week and how much weight?

\|___\| times/week pushed or pulled 10 lbs or less
\|___\| times/week pushed or pulled 11–50 lbs
\|___\| times/week pushed or pulled 51–100 lbs
\|___\| times/week pushed or pulled more than 100 lbs

32. Prior to your current deployment, did you use a seat cushion when you drove? ☐ 0 No ☐ 1 Yes

## DEPLOYMENT HISTORY AND CURRENT ACTIVITIES

33. How many times have you been deployed overseas for one month or more? |____| times
*(If this is your first deployment, write 1.)*

34. If you were deployed, where did you serve and when did you serve? *(List your current deployment.)*
Deployment 1: Where? _____ When? From ____/____ To: ____/____
*(month/year, e.g. 11/07)*
Deployment 2: Where? _____ When? From ____/____ To: ____/____
Deployment 3: Where? _____ When? From ____/____ To: ____/____
Deployment 4: Where? _____ When? From ____/____ To: ____/____

35. In your **current** deployment, list the information below for each vehicle you drive. Rate the comfort of the seats in these vehicles. *(If you do not drive, stop here and leave the remaining questions blank.)*

| | Type | Hours per run | Runs per month | Miles per run | Seat Comfort Rating *(1=low comfort, 5=high comfort)* 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle 1 | _____ | \|____\| | \|____\| | \|____\| | ☐ | ☐ | ☐ | ☐ | ☐ |
| Vehicle 2 | _____ | \|____\| | \|____\| | \|____\| | ☐ | ☐ | ☐ | ☐ | ☐ |
| Vehicle 3 | _____ | \|____\| | \|____\| | \|____\| | ☐ | ☐ | ☐ | ☐ | ☐ |

36. In your **current** deployment, do you experience discomfort due to road vibration/jolts when you drive?
☐$_0$ No ☐$_1$ Yes ☐$_2$ NA

37. In your **current** deployment, does your work require you to lift with your hands? ☐$_0$ No ☐$_1$ Yes
How many times/week and how much weight?
|____| times/week lift 10 lbs or less |____| times/week lift 11–50 lbs
|____| times/week lift 51–100 lbs |____| times/week lift more than 100 lbs

38. In your **current** deployment, do you drive and then lift immediately after?
☐$_0$ no ☐$_1$ seldom ☐$_2$ occasionally ☐$_3$ often

39. In your **current** deployment, does your job require you to push or pull loads? ☐$_0$ No ☐$_1$ Yes
How many times/week and how much weight?
|____| times/week push or pull 10 lbs or less |____| times/week push or pull 11–50 lbs
|____| times/week push or pull 51–100 lbs |____| times/week push or pull more than 100 lbs

40. In your **current** deployment, do you drive and then push or pull immediately after?
☐$_0$ no ☐$_1$ seldom ☐$_2$ occasionally ☐$_3$ often

41. In your **current** deployment, do you have to sit in a twisted posture for long periods of time while you drive? ☐ 0 No ☐ 1 Yes

42. In your **current** deployment, do you use a seat cushion with a back rest when you when you drive? ☐ 0 No ☐ 1 Yes

43. In your **current** deployment, do you take breaks on drives longer than 2 hours? ☐ 0 No ☐ 1 Yes
    If yes, how long are these breaks? |____| minutes each time

44. In your **current** deployment, do you experience back pain after driving/riding in a vehicle? ☐ 0 No ☐ 1 Yes
    If yes, how would you rate this pain? *(light pain)* 1 2 3 4 5 6 7 8 9 10 *(very severe pain)*
    ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

45. Are there any duties or activities you perform, other than driving/riding, that put stress on your low back?

# APPENDIX E. MISSION QUESTIONNAIRE (Example)

1. Name: _____ *(Last, First, Middle)*
2. Last 4 digits of SSN: _____
3. Today's Date: _____
4. Final Destination _____
5. Vehicle Type: _____
6. Mission Duration: |___| days
7. Hours Driven per Day: |___| hours
8. Total Mission Miles Driven |___| miles
9. How long have you been on your current deployment? |___| months
10. During the mission did you use the Skydex seat pad? ☐ 1 Yes ☐ 0 No

If Yes, what percent of time did you useit? 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

11. On this driving mission, while you were on the road, what percent of the time were you:

| | 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. driving | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. other than driving | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

12. Just **prior** to this mission what what was your overall back pain/discomfort level :

| *(none)* 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 *(extreme)* |
|---|---|---|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

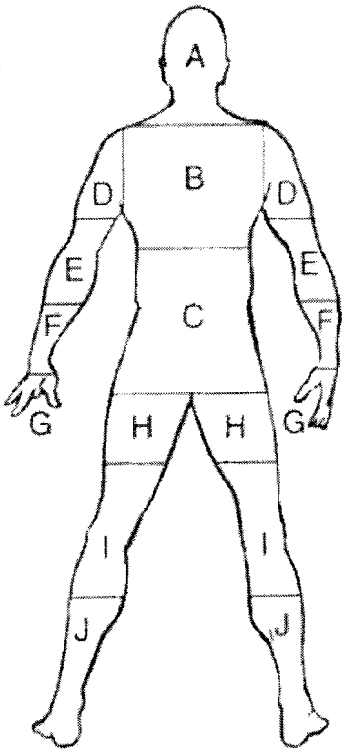
13. Just **after** the mission what was your overall back pain/discomfort level:

| *(none)* 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 *(extreme)* |
|---|---|---|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

14. Rate your pain/ discomfort for each body segment, during this mission. Fill in a box for each line below.

*No Pain/Discomfort* *Extreme Pain/Discomfort*

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A. Head/neck/eyes | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| B. Upper/mid back | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| C. Low back/pelvis | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| D. Shoulder/upper arm | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| E. Elbow/mid arm | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| F. Forearm/wrist | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| G. Hand | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| H. Upper leg/hip | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I. Mid leg/knee | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| J. Lower leg/foot | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |



15. What percent of the time did you drive on these types of road?

| | 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Primary (paved) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Secondary (dirt, gravel) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| c. Cross Country | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

16. Rate the overall level of road vibration/jolts felt during the mission:

*very smooth* — *neutral* — *extreme vibration/jolts*

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

**IF YOU DID NOT USE THE SKYDEX SEAT PAD, LEAVE THE REMAINING QUESTIONS BLANK.**

17. Rate the Skydex seat pad in terms of comfort.

*very uncomfortable* — *neutral* — *very comfortable*

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

18. Rate the ability of the Skydex seat pad to reduce shock and vibration.

*poor* — *fair* — *neutral* — *good* — *very good*

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

19. Did the Skydex seat pad affect the typical back pain/discomfort you encounter when you drive vehicles?

*less pain/discomfort* — *no effect* — *more pain/discomfort*

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

20. What do you LIKE about the seat pad?

_____

_____

_____

21. What do you NOT LIKE about the seat pad?

_____

_____

_____

# APPENDIX F. POST PROJECT QUESTIONNAIRE (EXAMPLE)

In this questionnaire you will be asked about yourself, your lifestyle, past injuries, and your work and deployment history. Please answer each question to the best of your ability.

1. Name: _____ 2. SSN: _____
*(Last, First, Middle)*

3. Today's Date: ____/____/____
*month/day/year (e.g., 1/3/07)*

4. Height: |____| feet |____| inches 5. Weight: |_____| pounds

**PHYSICAL ACTIVITY**

6. Compared with others your same age and sex in the Army, how would you rate yourself as to the amount of physical activity you perform?

☐ 1 Much less active ☐ 2 Somewhat less active ☐ 3 About the same ☐ 4 Somewhat more active ☐ 5 Much more active

7. Over the last two months, what was the average number of times per week you exercised or played sports for at least
30 minutes at a time?

☐ 0 Never
☐ 1 Less than 1 time per week
☐ 2 1 time per week
☐ 3 2 times per week
☐ 4 3 times per week
☐ 5 4 times per week
☐ 6 5 times per week
☐ 7 6 times per week
☐ 8 7 times or more per week

**TOBACCO USE**

8. During the past 30 days, on how many days did you smoke a cigarette?
*(If you have never smoked or not smoked in the last 30 days, write 0)* |____| days

9. During the past 30 days, on the days you smoked, how many cigarettes did you smoke <u>per day</u>?
*(If you have never smoked or not smoked in the last 30 days, write 0)*
|____| cigarettes

10. If you used to smoke cigarettes and quit, how many months <u>or</u> years ago did you quit?
*(If you have never smoked, write 00)* |____| months |____| years

11. During the past 30 days, on how many days did you use smokeless tobacco (chewing, snuffing, pinching, etc)?
*(If you have never used smokeless tobacco or not used any in the last 30 days, write 0)*
|____| days

12. During the past 30 days, on the days you used smokeless tobacco, how many cans, pouches or plugs did you use <u>per day</u>?
*(If you have never used smokeless tobacco or not used it in the last 30 days, write 0)*
|____| cans, pouches, or plugs

**RECENT INJURY**

13. Within the last six months did you have an injury? ☐ 0 No ☐ 1 Yes If yes, please indicate the body area involved, the type of injury, the cause of the injury, and the number of limited duty days, if any. If no, go to the next page and continue with Question 15.

**INJURY (Most Serious Injury in Last 6 Months)**

a. **Body Area of Injury** *(select one)*

- ☐ Head
- ☐ Face
- ☐ Ear
- ☐ Eye
- ☐ Neck
- ☐ Chest
- ☐ Abdomen
- ☐ Upper Back
- ☐ Lower Back
- ☐ Shoulders
- ☐ Elbow
- ☐ Upper Arm
- ☐ Lower Arm
- ☐ Wrist
- ☐ Hand
- ☐ Finger
- ☐ Hip
- ☐ Thigh
- ☐ Knee
- ☐ Calf/Shin
- ☐ Ankle
- ☐ Foot
- ☐ Toe
- ☐ Other *(list below)*

_____

_____

b. **Type of Injury** *(select one)*

- ☐ Dislocation
- ☐ Fracture
- ☐ Blister
- ☐ Abrasion
- ☐ Cut (Laceration)
- ☐ Bruise
- ☐ Stress Fracture
- ☐ Tendonitis
- ☐ Bursitis
- ☐ Fasciitis
- ☐ Strain
- ☐ Sprain
- ☐ Heat Injury
- ☐ Cold Injury
- ☐ Insect or Animal Bite
- ☐ Joint Pain
- ☐ Pinched Nerve
- ☐ Other *(list below)*

_____

_____

c. **Cause of Injury** *(select one)*

- ☐ Physical Training (PT)
- ☐ APFT
- ☐ Sports during PT
- ☐ Sports (other)
- ☐ Military Vehicle Accident
- ☐ POV Accident
- ☐ Road Marching
- ☐ Field Training
- ☐ Airborne Jump
- ☐ Garrison or Home Activity
- ☐ Horseplay/Fighting
- ☐ Ice
- ☐ Chronic (Recurrent) Condition
- ☐ Other *(list below)*

_____

_____

d. Total days of limited duty for injury described above *(if none, write 0)* |___| days

e. Did you go to a medical facility, battalion aid station, or see a doctor or other health care provider for this injury?
☐ 0 No ☐ 1 Yes

4. Did you have more than one injury in the last 6 months? ☐ 0 No ☐ 1 Yes

**LOW BACK PAIN**

15. **LOW BACK PAIN:** Please answer the following questions regarding low back pain you have experienced **in the last 7 days and last 6 months.**

| | **During the last 7 days** | **During the past 6 months** |
|---|---|---|
| a. Did you have aches, pain, discomfort or other symptoms with your low back? | ☐ 0 Never<br>☐ 1 Seldom<br>☐ 2 Often | ☐ 0 Never *(Go to Question 16)*<br>☐ 1 Seldom<br>☐ 2 Often |
| b. Was your back trouble: | ☐ 3 Constant<br>☐ 2 Comes and goes (episodic)<br>☐ 1 Only happened once | ☐ 3 Constant<br>☐ 2 Comes and goes (episodic)<br>☐ 1 Only happened once |
| c. How many episodes did you have with your low back trouble? | \|___\| Episodes in last 7 days | \|___\| Episodes in last 6 months |
| d. How many days did your low back trouble typically last? | \|___\| Days in last 7 days | \|___\| Days in last 6 months |
| e. How many days of profile were you given for your low back problem? | ☐ 0 None<br>\|___\| Profile days in last 7 days | ☐ 0 None<br>\|___\| Profile days in last 6 months |
| f. Where was the low back trouble? | ☐ 1 Low back only<br>☐ 2 Low back and buttocks<br>☐ 3 Low back, buttocks and legs<br>☐ 4 Low back and other _____ | ☐ 1 Low back only<br>☐ 2 Low back and buttocks<br>☐ 3 Low back, buttocks and legs<br>☐ 4 Low back and other _____ |
| g. Was there any movement that **caused** your low back trouble? | ☐ 0 No ☐ 1 Yes<br>If yes, what movement?<br>_____ | ☐ 0 No ☐ 1 Yes<br>If yes, what movement?<br>_____ |
| h. Was there any movement that **aggravated** your low back trouble? | ☐ 0 No ☐ 1 Yes<br>If yes, what movement?<br>_____ | ☐ 0 No ☐ 1 Yes<br>If yes, what movement?<br>_____ |

How would you rate the severity of this low back trouble during the following activities?

*(0=no trouble, 1= very low severity, 10=highest severity)*

| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| i. driving | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| j. lifting | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| k. walking | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| l. standing | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| m. sitting | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| n. sleeping | Last 7 Days | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Last 6 Months | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**ACTIVITIES IN LAST SIX MONTHS**

16. List the information below for each vehicle you drove in the last 6 months. Rate the comfort of the seats in these vehicles.

| | Type | Hours per run | Runs per month | Miles per run | Seat Comfort Rating *(1=low comfort, 5=high comfort)* 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle 1 | _____ | \|___\| | \|___\| | \|___\| | ☐ | ☐ | ☐ | ☐ | ☐ |
| Vehicle 2 | _____ | \|___\| | \|___\| | \|___\| | ☐ | ☐ | ☐ | ☐ | ☐ |
| Vehicle 3 | _____ | \|___\| | \|___\| | \|___\| | ☐ | ☐ | ☐ | ☐ | ☐ |

17. In the last 6 months, did you experience discomfort due to road vibration/jolts when you drive? ☐ 0 No ☐ 1 Yes

18. In the last 6 months, did your work require you to lift with your hands? ☐ 0 No ☐ 1 Yes
How many times/week and how much weight?

\|___\| times/week lifted 10 lbs or less \|___\| times/week lifted 11–50 lbs

\|___\| times/week lifted 51–100 lbs \|___\| times/week lifted more than 100 lbs

19. In the last 6 months, did you drive and then lift immediately after? ☐ 0 no ☐ 1 seldom ☐ 2 occasionally ☐ 3 often

20. In the last 6 months, did your job require you to push or pull loads? ☐ 0 No ☐ 1 Yes
How many times/week and how much weight?

\|___\| times/week pushed or pulled 10 lbs or less \|___\| times/week pushed or pulled 11–50 lbs

\|___\| times/week pushed or pulled 51–100 lbs \|___\| times/week pushed or pulled more than 100 lbs

21. In the last 6 months, did you drive and then push or pull immediately after?
☐ 0 no ☐ 1 seldom ☐ 2 occasionally ☐ 3 often

22. In the last 6 months, did you have to sit in a twisted posture for long periods while you drove? ☐ 0 No ☐ 1 Yes

23. In the last 6 months, did you use a seat cushion with a support rest when you drove? ☐ 0 No ☐ 1 Yes

24. In the last 6 months, did you take breaks on drives longer than 2 hours? ☐ 0 No ☐ 1 Yes
If yes, how long were these breaks? \|___\| minutes each time

25. In the last 6 months, did you experience back pain while driving/riding in a vehicle or after driving/riding in a vehicle? ☐ 0 No ☐ 1 Yes
If yes, how would you rate this pain? *(light pain)* 1 2 3 4 5 6 7 8 9 10 *(very severe pain)*
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

26. In the last 6 months, were there any duties or activities you performed, other than driving/riding, that put stress on your low back?

_____

If you DID NOT use the Skydex seat pad, STOP HERE

If you DID use the Skydex seat pad, please ***answer the remaining questions.***

27. On how many missions did you use the Skydex seat pad? |____| missions

Provide your overall assessment of the Skydex seat pad during the times you used the pad:

28. Rate the Skydex seat pad in terms of comfort.

*very uncomfortable* *neutral* *very comfortable*

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

29. Rate the ability of the Skydex seat pad to reduce shock and vibration.

*poor* *fair* *neutral* *good* *very good*

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

30. Did the Skydex seat pad affect the typical back pain/discomfort you encounter when you drive vehicles?

*less pain/discomfort* *no effect* *more pain/discomfort*

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

31. What did you LIKE about the seat pad?

_____

_____

_____

32. What did you NOT LIKE about the seat pad?

_____

_____

_____

# APPENDIX G.

## COMPARISON OF INITIAL NSP AND SP GROUPS ON THE BACKGROUND QUESTIONNAIRE

1. This Appendix compares the initial cohort of 53 Soldiers in the NSP group and 45 Soldiers in the SP group. This analysis was completed before the project team returned to Kuwait for the intervention measures and since the cohort of drivers was larger, it might be of interest to those who desire additional information on drivers.

2. Responses to Question 8 on the questionnaire indicated that the NSP group had served more time in Kuwait on their current deployment than the SP group, 85±45 versus 50±14 days ($p<0.01$). Responses to Question 27 indicated that the NSP group was composed of Army Reservists (n=34) and National Guardsmen (n=19), while the SP group (n=45) was all active Army.

3. Background Survey. Not all Soldiers responded to all items on the Background Survey. For this reason, sample sizes are provided for summarized data from the questionnaire.

a. Physical Characteristics and Physical Fitness. Table G1 shows a comparison of the groups on their physical characteristics and physical fitness. The SP group reported that they were heavier and had a higher calculated body mass index (calculated from height and weight). The SP group also had a higher level of physical fitness as evidenced by more reported sit-ups and faster reported two-mile run times. The NSP and SP groups reported taking their last APFT 161±211 and 93±42 days prior to the start of the project ($p=0.06$), respectively. The longer time since the last APFT for the NSP group was partly due to 3 Soldiers who reported that their last APFT had been administered over 1 year ago.

Table G1. Comparison of Groups on Physical Characteristics and Physical Fitness

| Question #. Variable | No Seat Pad Group | | Seat Pad Group | | |
|---|---|---|---|---|---|
| | N | Mean±SD | n | Mean±SD | p-value[a] |
| Q4. Age (yrs) | 52 | 28.3±7.3 | 45 | 26.7±5.9 | 0.26 |
| Q6. Height (in) | 53 | 70±3 | 45 | 70±3 | 0.75 |
| Q7. Weight (lbs) | 53 | 180±27 | 45 | 189±25 | 0.08 |
| Body Mass Index ($kg/m^2$) | 53 | 25.6±3.4 | 45 | 26.9±3.6 | 0.08 |
| Q12a. Push-Ups (n) | 51 | 60±17 | 43 | 61±9 | 0.73 |
| Q12b. Sit-Ups (n) | 52 | 61±15 | 42 | 65±9 | 0.08 |
| Q12c. 2-Mile Run Times (min) | 49 | 16.0±1.4 | 39 | 15.4±1.3 | 0.03 |

Notes:
[a]From independent sample t-test

b. Physical Activity and Tobacco Use. Table G2 shows a comparison of the groups on responses to the questions on physical activity and tobacco use. Group differences were small.

Packs of cigarettes smoked in the last month was calculated by multiplying the number of days smoking in the last month (Question 13) by cigarettes smoked per day (Question 14) and dividing by 20 (the numbers of cigarettes in a pack). When the two groups were compared on this calculation, it was found that that smokers in the NSP group smoked more cigarettes in the last month than cigarette smokers in the SP group (13±11 pack-month versus 22±16 pack-month, p=0.04). Cans/pouches/plugs consumed in the last month was calculated by multiplying the number of days using smokeless tobacco (Question 16) by cans/pouches/plugs consumed per day (Question 17). This calculation showed that smokeless tobacco users in the NSP group consumed 19±17 cans/pouches/plugs in the last month while the smokeless tobacco users in the SP group consumed 27±29 cans/pouches/plugs in the last month (p=0.46). There were 5 Soldiers in the NSP group and 6 Soldiers in the SP group who reported that they had quit smoking 47±42 months ago and 47±39 months ago, respectively (p=0.99, Question 15).

Table G2. Comparison of Groups on Physical Activity and Tobacco Use

| Question #. Variable | Level Of Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|---|
| | | n | Proportion (%) | n | Proportion (%) | |
| Q9. Physical Activity Compared to Peers | Much Less Active | 0 | 0.0 | 0 | 0.0 | 0.83 |
| | Less Active | 4 | 7.5 | 4 | 8.9 | |
| | About the Same | 23 | 43.4 | 20 | 44.4 | |
| | More Active | 14 | 26.4 | 14 | 31.1 | |
| | Much More Active | 12 | 22.6 | 7 | 15.6 | |
| Q10. Exercise or Sports Frequency | ≤1 time/week | 1 | 1.9 | 2 | 4.4 | 0.76 |
| | 2-3 times/week | 13 | 24.5 | 11 | 24.4 | |
| | ≥4 times/week | 39 | 73.6 | 32 | 71.1 | |
| Q13. Days Smoking in Last 30 Days | No Cigarette Use | 29 | 54.7 | 19 | 42.2 | 0.47 |
| | 1-19 Days | 3 | 5.7 | 3 | 6.7 | |
| | ≥20 Days | 21 | 39.6 | 23 | 51.1 | |
| Q14. Cigarettes per Day in Last 30 Days | Non Smoker | 29 | 54.7 | 19 | 44.4 | 0.19 |
| | 1-19 Cigarettes | 13 | 24.5 | 18 | 41.9 | |
| | ≥20 Cigarettes | 11 | 20.8 | 6 | 14.0 | |
| Q16. Days Chewed, Last 30 Days | No Smokeless Tobacco Use | 42 | 79.2 | 26 | 60.5 | 0.13 |
| | 1-19 Days | 5 | 9.4 | 8 | 18.6 | |
| | ≥20 Days | 6 | 11.3 | 9 | 20.9 | |
| Q17. Cans Chewed, Last 30 Days | No Smokeless Tobacco Use | 42 | 79.2 | 27 | 64.3 | 0.20 |
| | ≤1 Can | 10 | 18.9 | 12 | 28.6 | |
| | >1 Can | 1 | 1.9 | 3 | 7.1 | |

Notes:
[a]From chi-square test

c. Recent Injuries. Table G3 shows a group comparison on the questions dealing with injuries in the last 6 months. Group differences were small in the proportion of Soldiers experiencing injuries. There were also little group differences in the proportion of Soldiers analyzed by injury location, injury type, proportion seeking medical care, or those having more than one injury. For injury type, overuse injuries included bursitis, tendonitis, and joint pain, while traumatic injuries included sprains, strains, and blisters. NSP and SP groups had an average±SD of 6±9 days and 11±17 days of limited duty as a result of these injuries, respectively (p=0.29) (Question 18d).

Table G3. Comparison of Groups on Injuries in the Last 6 Months

| Question #. Variable | Level Of Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|---|
| | | N | Proportion (%) | N | Proportion (%) | |
| Q18. Any Injury In Last 6 Months | No | 34 | 65.4 | 29 | 64.4 | 0.92 |
| | Yes | 18 | 34.6 | 16 | 35.6 | |
| Q18a. Injury Location | No Injury | 34 | 65.4 | 29 | 65.9 | |
| | Upper Body | 6 | 11.5 | 5 | 11.4 | |
| | Lower Back | 5 | 9.6 | 6 | 13.6 | 0.87 |
| | Lower Body | 7 | 13.5 | 4 | 9.1 | |
| Q18b. Injury Type | No Injury | 34 | 70.8 | 29 | 67.4 | |
| | Overuse | 6 | 12.5 | 6 | 14.0 | 0.69 |
| | Traumatic | 5 | 10.4 | 7 | 16.3 | |
| | Other | 3 | 6.2 | 1 | 2.3 | |
| Q18e. Sought Medical Care | No Injury | 34 | 66.7 | 29 | 65.9 | |
| | No | 6 | 11.8 | 4 | 9.1 | 0.87 |
| | Yes | 11 | 21.6 | 11 | 25.0 | |
| Q19. More than One Injury | No Injury | 34 | 65.4 | 29 | 63.0 | |
| | No | 11 | 21.2 | 15 | 32.6 | 0.18 |
| | Yes | 7 | 13.5 | 2 | 4.3 | |

Notes:
[a]From chi-square test

d. Activities Associated with Injury. Table G4 shows the activities associated with injury (Question 18C). Sports and physical training were the activities associated with the largest proportion of injuries (35% for both groups combined). Driving-related events were associated with 22% of the injuries in the NSP group but only 6% of injuries in the SP group.

Table G4. Activities Associated With Injury in the Last Six Months

| Activity | No Seat Pad Group | | Seat Pad Group | |
|---|---|---|---|---|
| | n | Proportion (%) | n | Proportion (%) |
| Physical Training | 4 | 22.2 | 3 | 18.8 |
| Sports | 0 | 0.0 | 5 | 31.3 |
| Field Activities | 3 | 16.7 | 5 | 31.3 |
| Garrison/Home Activities | 1 | 5.6 | 1 | 6.3 |
| Chronic Conditions | 1 | 5.6 | 1 | 6.3 |
| Driving | 4 | 22.2 | 1 | 6.3 |
| Unknown | 2 | 11.1 | 0 | 0.0 |
| Missing (No Response) | 3 | 16.7 | 0 | 0.0 |

e. Low Back Pain. Table G5 shows group comparisons on the ordinal or nominal variables on the low back pain questions (Questions 20a-21). There were few group differences in responses to these questions. For the NSP and SP groups, 73% and 84% reported low back pain in the last 7 days (Question 20a "seldom" and "often" combined, relative risk (SP/NSP)=1.16, 95%CI=0.94-1.44). For the NSP and SP groups, 78% and 84% reported low back pain in the last

6 months ("seldom" and "often" combined, relative risk (SP/NSP)=1.07, 95%CI=0.88-1.30). The large majority of Soldiers only had episodic LBP and overall, very few Soldiers had received a profile for this problem in the last 7 days (n=3) or in the last 6 months (n=6). The location of the LBP was primarily in the low back exclusively (Question 20f) only but some Soldiers reported pain in other places as well, especially the buttock and legs.

Table G5. Groups Comparisons on Low Back Pain Questions

| Question #. Variable | Value | During Last 7 Days | | | | | During Past 6 Months | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No Seat Pad Group | | Seat Pad Group | | p-value[a] | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
| | | n | Proportion (%) | n | Proportion (%) | | n | Proportion (%) | n | Proportion (%) | |
| Q20a. Aches, Pain, Discomfort with LB | Never | 14 | 27.5 | 7 | 15.6 | 0.37 | 11 | 21.6 | 7 | 16.3 | 0.63 |
| | Seldom | 17 | 33.3 | 17 | 37.8 | | 21 | 41.2 | 16 | 37.2 | |
| | Often | 20 | 39.2 | 21 | 46.7 | | 19 | 37.3 | 20 | 46.5 | |
| Q20b. Frequency of LBP | Constant | 2 | 5.4 | 4 | 1.8 | 0.27 | 1 | 2.6 | 2 | 5.7 | 0.24 |
| | Episodic | 31 | 83.8 | 25 | 67.6 | | 34 | 89.5 | 26 | 74.3 | |
| | Once | 4 | 10.8 | 8 | 21.6 | | 3 | 7.9 | 7 | 20.0 | |
| Q20e Profiled for LBP | No | 35 | 97.2 | 35 | 94.6 | 0.57 | 35 | 92.1 | 33 | 91.7 | 0.95 |
| | Yes | 1 | 2.8 | 2 | 5.4 | | 3 | 7.9 | 3 | 8.3 | |
| Q20f. Location of LBP | LB | 17 | 48.6 | 17 | 45.9 | 0.73 | 22 | 59.5 | 16 | 47.1 | 0.71 |
| | LB/Buttocks | 2 | 5.7 | 5 | 13.5 | | 3 | 8.1 | 5 | 14.7 | |
| | LB/Buttocks/Legs | 10 | 28.6 | 9 | 24.3 | | 7 | 18.9 | 8 | 23.5 | |
| | Other | 6 | 17.1 | 6 | 16.2 | | 5 | 13.5 | 5 | 14.7 | |
| 20g. Movement Causing LBP | No | 26 | 70.3 | 23 | 62.2 | 0.46 | 27 | 69.2 | 22 | 64.7 | 0.68 |
| | Yes | 11 | 29.7 | 14 | 37.8 | | 12 | 30.8 | 12 | 35.3 | |
| 20h. Movement Aggravated LBP | No | 20 | 54.1 | 19 | 54.3 | 0.44 | 21 | 53.8 | 20 | 64.5 | 0.37 |
| | Yes | 17 | 45.9 | 16 | 45.7 | | 18 | 46.2 | 11 | 35.5 | |

Legend: LBP=Low Back Pain, LB=Low Back

f. Tables G6 and G7 show that among Soldiers reporting that a particular movement caused or aggravated their LBP (Question 20g and 20h, respectively), the predominate movement was bending and twisting. Vehicle operations were also associated with a large proportion of LBP in the last 7 days.

Table G6. Movements Causing Low Back Pain (Question 20g)

| Activity | During Last 7 Days | | | | During Past 6 Months | | | |
|---|---|---|---|---|---|---|---|---|
| | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | |
| | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) |
| Vehicle Operations | 3 | 27.3 | 3 | 21.4 | 1 | 8.3 | 0 | 0.0 |
| Physical Training | 1 | 9.1 | 2 | 14.3 | 1 | 8.3 | 3 | 25.0 |
| Bending/Twisting | 6 | 54.5 | 6 | 42.8 | 5 | 41.6 | 5 | 41.6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Various or Sudden Movements | 1 | 9.1 | 1 | 7.1 | 1 | 8.3 | 0 | 0.0 |
| Lifting/Pulling | 0 | 0.0 | 2 | 14.3 | 1 | 8.3 | 2 | 16.7 |
| Any Movement | 0 | 0.0 | 0 | 0.0 | 2 | 16.7 | 1 | 8.3 |
| Sitting/Lying Down | 0 | 0.0 | 0 | 0.0 | 1 | 8.3 | 1 | 8.3 |

Table G7. Movements Aggravating Low Back Pain (Question 20h)

| Activity | During Last 7 Days | | | | During Past 6 Months | | | |
|---|---|---|---|---|---|---|---|---|
| | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | |
| | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) | n | Proportion (%) |
| Vehicle Operations | 3 | 17.6 | 2 | 12.5 | 2 | 11.1 | 2 | 18.2 |
| Physical Training | 2 | 11.8 | 5 | 31.3 | 2 | 11.1 | 3 | 27.3 |
| Bending/Twisting | 6 | 35.3 | 2 | 12.5 | 5 | 27.8 | 2 | 18.2 |
| Lifting/Pulling | 2 | 11.8 | 0 | 0.0 | 3 | 16.7 | 0 | 0.0 |
| Any Movement | 1 | 5.6 | 1 | 6.3 | 2 | 11.1 | 1 | 9.1 |
| Sitting/Lying Down | 3 | 17.6 | 4 | 25.0 | 2 | 11.1 | 2 | 18.2 |
| Standing | 0 | 0.0 | 1 | 6.3 | 1 | 5.6 | 1 | 9.1 |
| No Response | 0 | 0.0 | 1 | 6.3 | 1 | 5.6 | 0 | 0.0 |

g. For Soldiers reporting LBP, Table G8 shows group comparisons for the continuous variables on Question 20. There were only minor differences between the two groups on these questions, although the SP group tended to report slightly more severe LBP than the NSP group while sleeping. For the most part, Soldiers rated their pain during driving, sitting, and sleeping slightly higher than for walking, standing, and/or lifting.

Table G8. Comparison of Groups on Low Back Pain Episodes, Duration, and Severity

| Question #. Variable[a] | During Last 7 Days | | | | | During Past 6 Months | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No Seat Pad Group | | Seat Pad Group | | p-value[a] | No Seat Pad Group | | Seat Pad Group | | p-value[b] |
| | n | Mean±SD | n | Mean±SD | | n | Mean±SD | n | Mean±SD | |
| Q20c Episodes of LBP (n) | 36 | 3±3 | 37 | 4±3 | 0.28 | 33 | 17±23 | 27 | 22±46 | 0.56 |
| Q20d Duration of LBP (days) | 37 | 2±2 | 36 | 3±3 | 0.08 | 35 | 16±30 | 28 | 32±62 | 0.20 |
| Q20i Severity LBP Driving | 37 | 4±3 | 38 | 4±2 | 0.68 | 39 | 4±3 | 37 | 4±2 | 0.63 |
| Q20j Severity LBP Lifting | 37 | 3±2 | 38 | 3±3 | 0.34 | 39 | 3±2 | 37 | 4±3 | 0.27 |
| Q20k Severity LBP Walking | 37 | 2±2 | 38 | 2±2 | 0.54 | 39 | 2±2 | 37 | 2±2 | 0.30 |
| Q20l Severity LBP Standing | 37 | 3±3 | 38 | 3±3 | 0.70 | 39 | 3±3 | 37 | 3±3 | 0.39 |
| Q20m Severity LBP Sitting | 37 | 4±3 | 38 | 4±3 | 0.64 | 38 | 3±3 | 37 | 4±3 | 0.37 |
| Q20n Severity LBP Sleeping | 37 | 3±3 | 38 | 4±3 | 0.06 | 39 | 3±3 | 37 | 4±3 | 0.04 |

Notes:

[a]LBP=Low back pain. Severity rating scales are 1 to 10 (low to high)
[b]Episodes and duration of LBP were analyzed using independent sample t-tests; the other variables were analyzed using Mann Whitney U tests

h. In response to Question 21, 88% and 87% of the NSP and SP groups, respectively, reported that they had had LBP at some point in their lives (p=0.82).

i. Work History.

(1) Table G9 shows the previous occupations reported by the Soldiers. Most of the Soldiers had previously worked in maintenance/construction or retail jobs or had been students. Table G10 shows that on average the Soldiers had worked 2 to 4 years in these previous jobs.

Table G9. Previous Occupations Reported by Soldiers (Question 22)

| Occupational Group | Previous Occupation 1 | | | | Previous Occupation 2 | | | | Previous Occupation 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | |
| | n | % | n | % | n | % | n | % | n | % | n | % |
| Maintenance/Construction | 8 | 15.7 | 16 | 37.2 | 3 | 11.1 | 1 | 4.3 | 1 | 6.7 | 2 | 16.7 |
| Student | 8 | 15.7 | 7 | 16.3 | 2 | 7.4 | 1 | 4.3 | 2 | 13.3 | 0 | 0.0 |
| Retail | 7 | 13.7 | 5 | 11.9 | 4 | 14.8 | 5 | 21.7 | 3 | 20.0 | 2 | 16.7 |
| Professional | 4 | 7.8 | 2 | 4.8 | 5 | 18.5 | 4 | 17.4 | 3 | 20.0 | 2 | 16.7 |
| Factory/Warehouse | 4 | 7.8 | 4 | 9.5 | 5 | 18.5 | 2 | 8.7 | 1 | 6.7 | 0 | 0.0 |
| Driving | 3 | 5.9 | 3 | 7.1 | 3 | 11.1 | 1 | 4.3 | 2 | 13.3 | 2 | 16.7 |
| Fire/Police | 4 | 7.8 | 1 | 2.4 | 1 | 3.7 | 3 | 13.0 | 1 | 6.7 | 2 | 0.0 |
| Medical | 2 | 3.9 | 2 | 4.8 | 2 | 7.4 | 1 | 4.3 | 1 | 6.7 | 0 | 0.0 |
| Military | 2 | 3.9 | 1 | 2.4 | 1 | 3.7 | 1 | 4.3 | 0 | 0.0 | 0 | 0.0 |
| Mechanic | 1 | 2.0 | 0 | 0.0 | 1 | 3.7 | 2 | 8.7 | 0 | 0.0 | 0 | 0.0 |
| Farming | 1 | 2.0 | 0 | 0.0 | 0 | 0.0 | 2 | 8.7 | 1 | 6.7 | 1 | 8.3 |
| Landscaping | 4 | 7.8 | 2 | 4.8 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 8.3 |
| Railroad | 3 | 5.9 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

Table G10. Comparison of Groups on Time in Previous Occupations (Question 22)

| Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|
| | n | Mean±SD | n | Mean±SD | |
| Years in Occupation 1 | 51 | 4±3 | 43 | 4±4 | 0.75 |
| Years in Occupation 2 | 27 | 4±5 | 23 | 3±3 | 0.40 |
| Years in Occupation 3 | 15 | 4±3 | 12 | 2±2 | 0.20 |

Notes:
[a]From independent sample t-test

(2) To obtain time in service, the date the Soldier reported completed BCT was backdated by 2 months. Table G11 shows that the NSP group had more time in service and time in their military occupational specialty (MOS) than the SP group.

Table G11. Comparison of Groups on Time in Service and Time in MOS (Questions 23 & 25)

| Question #. Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|
| | n | Mean±SD | n | Mean±SD | |
| Q23. Time in Service (Years)[b] | 49 | 9.0±6.8 | 43 | 5.4±5.3 | <0.01 |
| Q25. Time in MOS (Years) | 52 | 6.1±4.9 | 45 | 3.8±3.4 | <0.01 |

Notes:
[a]From independent sample t-test
[b]The date the Soldier reported completed BCT was backdated by 2 months

(3) Table G12 shows the Soldiers' MOSs. In the SP group all but one Solider was a motor transport operator or officer. The NSP group had a wider variety of MOSs with 23% working outside their MOS.

Table G12. Comparison of Groups on MOS (Question 24)

| MOS (MOS Number) | No Seat Pad Group | | Seat Pad Group | |
|---|---|---|---|---|
| | n | % | n | % |
| Motor Transport Operator (88M) | 40 | 75.5 | 43 | 97.7 |
| Motor Transport Officer (88A) | 1 | 1.9 | 1 | 2.2 |
| Wheeled Vehicle Mechanic (63B) | 4 | 7.5 | 0 | 0.0 |
| Combat Engineer (21B) | 3 | 5.7 | 0 | 0.0 |
| Infantryman (11B) | 1 | 1.9 | 0 | 0.0 |
| Field Artillery Data Systems Operator (13D) | 1 | 1.9 | 0 | 0.0 |
| Power Generator Equipment Repairer (52D) | 1 | 1.9 | 0 | 0.0 |
| Food Service Specialist (92G) | 1 | 1.9 | 0 | 0.0 |
| Unit Supply Specialist (92Y) | 1 | 1.9 | 0 | 0.0 |
| Information Systems Operator (74D) | 0 | 0.0 | 1 | 2.2 |

Notes:
[a]From independent sample t-test

(4) Table G13 shows the occupations outside the Army for the Reservists and National Guard Soldiers. Table G13 only contains Soldiers in the NSP group only since all SP Soldiers were active Army. Many NSP Soldiers were involved in professional work which included occupations like music conductor, clergy, and information technology. Factory work included distribution and warehousing occupations. Almost 20% of the Soldiers were students or had no occupation outside the Army Reserve or National Guard. There were few Soldiers who were involved in driving occupations outside the Army.

Table G13. Occupations Outside the Army Reported by Army Reservists and National Guardsmen (Question 27)

| Occupation | n | % |
|---|---|---|
| Professional | 7 | 13.2 |
| Factory Work | 6 | 11.3 |
| Student | 5 | 9.4 |
| Military | 5 | 9.4 |
| No Occupation | 5 | 9.4 |
| Construction | 4 | 7.5 |
| Fire/Police | 4 | 7.5 |
| Driving | 3 | 5.7 |
| Sales | 2 | 3.8 |
| Nurse Assistant | 1 | 1.9 |
| Mechanic | 1 | 1.9 |
| Landscaping | 1 | 1.9 |
| Railway Conductor | 1 | 1.9 |
| Retail (Hardware Store) | 1 | 1.9 |
| Missing | 7 | 13.2 |

(5) Table G14 shows the vehicles that the Soldiers reported previously driving for work. Compared to the SP group, Soldiers in the NSP group were 6 times more likely to have reported driving small trucks for work and three times more likely to report driving passenger vehicles for work. Compared to the NSP group, Soldiers in the SP group were almost 5 times more likely to have reported driving palletized loading systems for work.

Table G14. Vehicles Soldiers Reported Driving Previously for Work (Question 28)[a]

| Vehicle | Vehicle 1 | | | | Vehicle 2 | | | | Vehicle 3 | | | | All Vehicles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | |
| | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| Small Truck | 11 | 20.8 | 1 | 2.2 | 5 | 9.4 | 1 | 2.2 | 2 | 3.8 | 0 | 0.0 | 18 | 20.7 | 2 | 3.0 |
| Large Truck | 4 | 7.5 | 1 | 2.2 | 1 | 1.9 | 1 | 2.2 | 1 | 1.9 | 5 | 11.1 | 6 | 6.9 | 7 | 10.6 |
| Passenger Vehicle | 12 | 22.6 | 2 | 4.4 | 9 | 17.0 | 3 | 6.7 | 3 | 5.7 | 3 | 6.7 | 24 | 27.6 | 8 | 12.1 |
| HMMWV[b] | 7 | 13.2 | 8 | 17.8 | 5 | 9.4 | 7 | 15.5 | 5 | 9.4 | 1 | 2.2 | 17 | 19.5 | 16 | 24.2 |
| HET[c] | 6 | 11.3 | 6 | 13.3 | 1 | 1.9 | 1 | 2.2 | 2 | 3.8 | 0 | 0.0 | 9 | 10.3 | 7 | 10.6 |
| HEMMT[d] | 1 | 1.9 | 2 | 4.4 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 1.1 | 2 | 3.0 |
| PLS[e] | 1 | 1.9 | 11 | 24.4 | 3 | 5.7 | 8 | 17.8 | 0 | 0.0 | 0 | 0.0 | 4 | 4.6 | 19 | 28.8 |
| Tractor | 2 | 3.8 | 4 | 8.9 | 5 | 9.4 | 0 | 0.0 | 1 | 1.9 | 1 | 2.2 | 8 | 9.2 | 5 | 7.6 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Forklift | 2 | 3.8 | 0 | 0.0 | 2 | 3.8 | 0 | 0.0 | 1 | 1.9 | 0 | 0.0 | 6 | 6.3 | 0 | 0.0 |
| Tank | 0 | 0.0 | 1 | 2.2 | 1 | 1.9 | 1 | 2.2 | 0 | 0.0 | 1 | 2.2 | 1 | 1.1 | 3 | 4.2 |
| LMTV[e] | 0 | 0.0 | 0 | 0.0 | 1 | 1.9 | 1 | 2.2 | 1 | 1.9 | 2 | 4.4 | 2 | 2.1 | 3 | 4.2 |
| No Vehicle Reported | 6 | 11.3 | 8 | 17.8 | | | | | | | | | | | | |

Notes:
[a]Denominators used to calculate proportions (%) for Vehicle 1, 2, and 3 were 53 for NSP group and 45 for SP group. For "All Vehicles", denominators for proportions were the total number of vehicles, 87 for the NSP group and 66 for the SP group.
[b]HMMWV-High Mobility Multipurpose Wheeled Vehicle
[c]HET – Heavy Equipment Transporter
[d]HEMMT- Heavy Expanded Mobility Tactical Truck
[e]PLS – Palletized Loading System
[f]LMTV – Light Medium Tactical Vehicle

(6) Table G15 compares the groups on driving duration, frequency, distance and seat comfort for the vehicles the Soldiers previously drove for work. The SP group tended to report more driving duration and lower seat comfort on Vehicle 1 but other differences between groups were small.

Table G15. Group Comparisons on Driving Duration, Frequency, Distance and Seat Comfort While Driving in Vehicles for Previous Work (Question 28)

| Vehicle | Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|---|
| | | n | Mean±SD | n | Mean±SD | |
| Vehicle 1 | Duration (Hours/Run) | 41 | 6±6 | 27 | 9±11 | 0.11 |
| | Frequency (Runs/Month) | 41 | 19±18 | 25 | 16±35 | 0.61 |
| | Distance (Miles/Run) | 32 | 98±129 | 22 | 114±72 | 0.60 |
| | Comfort Rating[b] | 47 | 3±1 | 37 | 2±1 | <0.01 |
| Vehicle 2 | Duration (Hours/Run) | 31 | 4±3 | 17 | 11±23 | 0.25 |
| | Frequency (Runs/Month) | 31 | 16±15 | 16 | 22±43 | 0.43 |
| | Distance (Miles/Run) | 29 | 171±380 | 15 | 250±344 | 0.50 |
| | Comfort Rating[b] | 33 | 3±2 | 23 | 3±1 | 0.11 |
| Vehicle 3 | Duration (Hours/Run) | 15 | 3±3 | 9 | 8±6 | <0.01 |
| | Frequency (Runs/Month) | 15 | 16±16 | 7 | 10±12 | 0.40 |
| | Distance (Miles/Run) | 13 | 122±146 | 8 | 251±396 | 0.30 |
| | Comfort Rating[b] | 16 | 3±1 | 12 | 3±1 | 0.63 |

Notes:
[a]Duration, frequency, and distance were analyzed with independent sample t-tests; seat comfort was analyzed with Mann-Whitney U test
[b]Comfort rating scale is 1 to 5

(7) Table G16 shows a comparison of the groups on previous experience with road vibration, lifting, pushing/pulling and seat cushion use. A larger proportion of the SP group reported experience with road vibration, lifting during work, pushing/pulling during work. More Soldiers in the NSP group reported previously using seat cushions.

Table G16. Comparison of Groups on Prior Experience with Road Vibration, Lifting, Pushing/Pulling and Seat Cushion Use Prior to Deployment

| Question #. Variable | Level Of Variable | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|---|
| | | n | Proportion (%) | n | Proportion (%) | |
| Q29. Road Vibration During Work | No<br>Yes | 46<br>6 | 88.5<br>11.5 | 20<br>22 | 47.6<br>52.4 | <0.01 |
| Q30. Lifting During Work | No<br>Yes | 19<br>34 | 35.8<br>64.2 | 4<br>41 | 8.9<br>91.1 | <0.01 |
| Q31. Push/Pull During Work | No<br>Yes | 32<br>21 | 60.4<br>39.6 | 18<br>26 | 40.9<br>59.1 | 0.06 |
| Q32. Previously Use Seat Pad | No<br>Yes | 45<br>8 | 84.9<br>15.1 | 43<br>1 | 97.7<br>2.3 | 0.03 |

Notes:
[a]From chi-square test

j. Deployment History and Current Activities.

(1) Sixty percent (n=32) of the NSP group and 49% (n=22) of the SP group had been previously deployed (p=0.25). Table G17 shows the locations of the last 3 reported deployments. Of these, 55% had been deployments to Iraq and 27% had been deployments to Kuwait.

Table G17. Previous Deployment Locations (Question 34)

| Location | Deployment 1 | | | | Deployment 2 | | | | Deployment 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | | No Seat Pad Group | | Seat Pad Group | |
| | n | % | n | % | n | % | n | % | n | % | n | % |
| Iraq | 21 | 65.6 | 12 | 54.5 | 3 | 42.8 | 6 | 40.0 | 0 | 0.0 | 1 | 25.0 |
| Kuwait | 3 | 9.4 | 6 | 27.3 | 2 | 28.6 | 7 | 46.7 | 0 | 0.0 | 3 | 75.0 |
| Afghanistan | 0 | 0.0 | 3 | 13.6 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Germany | 2 | 6.3 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Korea | 1 | 3.1 | 1 | 4.5 | 1 | 14.3 | 1 | 6.7 | 1 | 100.0 | 0 | 0.0 |
| Other | 4 | 12.5 | 0 | 0.0 | 1 | 14.3 | 1 | 6.7 | 0 | 0.0 | 0 | 0.0 |
| Missing | 1 | 3.1 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

(2) On Question 35 relating to the vehicles currently being driven, all Soldiers who responded reported using the HMMWV. Other vehicles included a 15-passanger bus, palletized loading system, heavy equipment transporter, bull dozer, and tractor; each of these was recorded by one Soldier. Table G18 shows group comparisons on HMMWV driving duration, frequency, distance, and seat comfort. The SP group reported longer driving duration, primarily because 4 subjects reported driving more than 20 hours/run (up to 40 hrs/run); no NSP group reported driving more than 20 hours/run. For driving frequency, 9 NSP and 4 SP Soldiers reported ≥20

runs/month. For driving distance, 4 NSP Soldiers reported driving over 2000/run miles while no SP group Soldier reported distance over 2000 miles/run. Both groups rated the seat comfort in the HMMWV as very low.

Table G18. Group Comparisons on Driving Duration, Frequency, Distance and Seat Comfort When Driving the High Mobility Multipurpose Wheeled Vehicle (Question 35)

| Variable | No Seat Pad | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|
| | N | Mean±SD | n | Mean±SD | |
| Duration (Hours/Run) | 43 | 6±3 | 33 | 10±9 | 0.02 |
| Frequency (Runs/Month) | 43 | 10±11 | 31 | 7±8 | 0.12 |
| Distance (Miles/Run) | 40 | 535±1049 | 27 | 567±583 | 0.88 |
| Seat Comfort[b] | 46 | 2±1 | 37 | 2±1 | 0.86 |

Notes:
[a]From independent sample t-test
[b]Comfort rating scale is 1 to 5

(3) Table G19 shows a comparison of the two groups on a number of measures relating to their current deployment experience. A greater proportion of Soldiers in the SP group reported discomfort with vibration or road jolts. A greater proportion of Soldiers in the NSP group reported prolonged sitting in a twisted position and greater current use of seat cushions/and backrests when driving. There were only small differences between groups in the proportion of Soldiers reporting that their current work required lifting, whether or not breaks were taken on longer drives, and the proportion havening back pain when driving or riding. The intensity of the back pain while driving (Question 44) was rated as 5±2 by the NSP group (n=40) and 6±2 by the SP group (n=38) on the 10 point scale (p=0.25).

Table G19. Group Comparisons on Current Experience with Road Vibration, Lifting, Pushing/Pulling, Twisted Postures, Seat Cushion Use, Driving Breaks, and Back Pain While Driving

| Quest #. Variable | Category | No Seat Pad Group | | Seat Pad Group | | p-value[a] |
|---|---|---|---|---|---|---|
| | | n | Proportion (%) | n | Proportion (%) | |
| Q36. Currently Experience Vibration | No<br>Yes<br>Missing | 16<br>29<br>4 | 76.2<br>45.3<br>8.2 | 5<br>35<br>4 | 23.8<br>81.4<br>7.0 | 0.05 |
| Q37. Current Work Requires Lifting | No<br>Yes | 7<br>43 | 14.0<br>86.0 | 3<br>40 | 7.0<br>93.0 | 0.28 |
| Q38. Currently Drive Then Lift Right Away | No<br>Seldom<br>Occasionally<br>Often | 6<br>12<br>13<br>17 | 12.5<br>25.0<br>27.1<br>35.4 | 7<br>8<br>8<br>18 | 17.1<br>19.5<br>19.5<br>43.9 | 0.67 |
| Q39. Currently Have Job Requiring Push/Pull Loads | No<br>Yes | 34<br>15 | 69.4<br>30.6 | 26<br>15 | 63.4<br>36.6 | 0.55 |
| Q40. Currently Drive and | No | 31 | 62.0 | 19 | 45.2 | 0.09 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Push/Pull Immediately After | Seldom<br>Occasionally<br>Often | 4<br>7<br>8 | 8.0<br>14.0<br>16.0 | 10<br>9<br>4 | 23.8<br>21.4<br>9.5 | |
| Q41. Currently Sit in Twisted Posture for a Long Time | No<br>Yes | 28<br>22 | 56.0<br>44.0 | 15<br>22 | 34.9<br>65.1 | 0.04 |
| Q42. Currently Use Seat Cushion/Backrest When Driving | No<br>Yes | 35<br>15 | 70.0<br>30.0 | 40<br>2 | 95.2<br>4.8 | <0.01 |
| Q43. Currently Take Breaks on Drives >2 Hours | No<br>Yes | 46<br>4 | 92.0<br>8.0 | 36<br>7 | 83.7<br>16.3 | 0.22 |
| Q44. Currently Have Back Pain on Driving/Riding | No<br>Yes | 10<br>40 | 20.0<br>80.0 | 5<br>38 | 11.6<br>88.4 | 0.27 |

Notes:
[a]From chi-square test

(4) Table G20 shows activities other than driving that the Soldiers reported that put stress on the back. In this case a Soldier could have had more than one response and all responses are shown. There were a total of 20 Soldiers in NSP group and 15 Soldiers in the SP group that provided responses. Physical training accounted for 47% of all responses and lying down/sleeping accounted for 16% of all responses.

Table G20. Activities Other than Driving/Riding That Soldiers Reported Put Stress on Their Backs (Question 45)

| Activity | No Seat Pad Group | Seat Pad Group |
|---|---|---|
| Physical Training[a]<br>Weight Lifting<br>Running<br>Calisthenics | 6<br>5<br>2<br>0 | 4<br>1<br>2<br>1 |
| Lying Down/Sleeping | 3 | 4 |
| Gunner Activities | 1 | 2 |
| Loading/Unloading Activities | 3 | 0 |
| Standing/Formations | 2 | 2 |
| Body Armor | 3 | 0 |
| Pulling | 1 | 0 |
| Truck Maintenance | 1 | 0 |
| Same Posture Too Long | 0 | 1 |
| Depends on Day | 0 | 1 |

Notes:
[a]Categories under physical training are exclusive of physical training alone.

# APPENDIX H

## EXACT RESPONSES TO WHAT SOLDIERS LIKED AND DISLIKED ABOUT THE SEAT PAD (RESPONSES TO QUESTIONS 31 AND 32 ON THE POST-PROJECT QUESTIONNAIRE)

LIKED ABOUT THE SEAT PAD

1. Reduced vibrations in vehicle
2. The back support
3. Reduces back pain slightly
4. Helped me sit upright. Helped reduce some back pain, while wearing body armor
5. The back pad was good for a pillow
6. A little more comfortable
7. It was soft but could not use it
8. Lumbar support under the back of body armor
9. Lumbar pad made a good pillow on steering wheel
10. Portable
11. Could be used for more than just driving
12. Contours to your back
13. Comfortable
14. If you used the seat less than an hour it was very nice
15. Comfortable in bigger vehicle
16. Back support for lower back
17. More comfortable than not having it. I liked it without vest
18. Very comfortable with softer back
19. Gave some support to my lower back. It was softer than the seat.
20. Very comfortable, takes away a lot of vibration
21. Works good in my chair in the PCB's
22. The back piece, it sat under my armor plates and added support
23. Only comfortable without vest
24. I sat up higher
25. It provided a variety of seating options

DID NOT LIKE ABOUT SEAT PAD

1. The back cushion is too bulky with body armor
2. Makes my butt sweat
3. More stuff to carry to truck. Not enough head room
4. The back rest really is not good for drivers because of wearing of the ACH
5. It is not effective for tall people in an M1151
6. Not enough room, unable to get comfortable

7. It was very uncomfortable
8. Tall people heads hit the roof often
9. I was unable to sit comfortably in the vehicle with it.
10. Reduced head room in M115. Hot in buttocks, made me sweat
11. I slid on the seat. Did not reduce vibration. Caused more discomfort.
12. It would not stay put. Is not wide enough it is uncomfortable.
13. Not thick enough
14. It did not fit well. It helped very little and was mostly just in the way
15. Provided little support for vibrations and movement of the vehicle
16. Constantly adjusting it as I rode on mission
17. It added too much height to my seat. Also it made the TL area too small.
18. After an hour your bottom sweat heavy. With all your gear on when using it in the (MRAP) you have to sit a certain way that makes your back pain unreal
It does not work
19. Not designed for 1151
20. Makes you hot, sit up too high
21. The back pad should be larger.
22. It raises the driver up too far
23. Raised me too high to see out of the windows, caused my head to be raised against the ceiling of the vehicle
24. Sits too high to the ceiling especially being 6'2"
25. The back rest
26. The butt pad was very inconvenient
27. Uncomfortable, does not help at all
28. No upper back support
29. It would move around a lot

# APPENDIX I

## FINAL FOCUS GROUP SESSION RESULTS

Items liked about the Seat Pad

- Lumbar support relived back pain
- Allows a higher position in the seat
- Lumbar supports allows better forward position with body armor
- Provides better cushioning
- Is more comfortable

Suggested Improvements

- Make lumbar support adjustable
- Add at least 4" to the straps that secure pad to seat
- Make lumbar support removable
- Provide better ventilation at seat bottom

# APPENDIX J

## COMPARISON OF SP GROUP MISSION SURVEYS COLLECTED BEFORE AND AFTER 9 FEBURARY 2009

1. This appendix compares mission surveys collected from the SP group before and after 9 February 2009. This is hereafter referred to as the "before" and "after" periods. In the before period (21 October 2008 through 9 February 2009), 242 mission surveys were returned by 51 Soldiers. In the after Period (15 February through 26 April 2009), 107 mission surveys were returned by 45 Soldiers. In the before period, all missions were reported to have been performed in HMMWV, with the exception of one mission performed in an MRAP vehicle. In the after period, 89 missions were made in HMMWVs (90%) and 18 missions in MRAPs (10%). In the before period, 48% of Soldiers (114/238) reported using the seat pads, while 37% (39/105) reported using them in the after period ($p=0.08$). Those Soldiers who used the seat pads reported using them 72±36% and 54±45% of the time in the before and after periods, respectively ($p<0.01$).

2. Table J1 compares various mission driving measures. Soldiers reported about 1 hour less driving on the missions in the after period (about 1 fewer days and about 200 total mission miles). There was little change in the proportion of time spent driving, the generally types of roads, or the ratings of road vibration.

Table J1. Self-Reported Mission Driving Measures

| | Before 9 Feb 09 | After 9 Feb 2009 | Difference (%) | p-value[a] |
|---|---|---|---|---|
| Q6. Mission Duration (days) | 8.5±3.1 | 7.6±1.9 | 10.6 | <0.01 |
| Q7. Mission Time (hours/day) | 6.4±2.1 | 6.8±2.9 | 6.3 | 0.16 |
| Q8. Mission Distance (miles) | 1164±626 | 968±381 | 16.8 | <0.01 |
| Q11a. Time Driving (%) | 34±41 | 36±41 | 5.6 | 0.78 |
| Q11b. Time Not Driving (%) | 62±42 | 53±44 | 14.5 | 0.14 |
| Q15a. Time On Primary (Paved) Roads (%) | 74±28 | 74±29 | 0.0 | 0.90 |
| Q15b. Time On Secondary (Dirt, Gravel) Roads (%) | 17±18 | 18±21 | 5.9 | 0.88 |
| Q15c. Percent of Time On Cross-Country Roads (%) | 6±16 | 6±14 | 0.0 | 0.83 |
| Q16. Rating of Road Vibration (1-10 scale) | 5.4±2.4 | 5.1±2.8 | 5.6 | 0.57 |

Notes:
[a]All variables tested with independent sample t-test, except road vibration which was tested with the Mann-Whitney U Test

3. Table J2 shows the reported back pain/discomfort just prior and after the missions for the two groups. Prior to the missions there was only a small difference between the before and after periods ($p<0.14$), so a two-way analysis of variance was performed. As Table J2 shows, there

were only small differences before or after the missions, in the before and after periods, and the interaction was not significant.

Table J2. Back Pain/Discomfort Just Before and After the Missions

| | Before 9 Feb 09 | After 9 Feb 09 | ANOVA p-values | | |
|---|---|---|---|---|---|
| | | | Before/After Mission | Before/After Date | Mission Time x Date |
| Q12. Back Pain Before the Mission | 3.0±2.7 | 2.5±2.6 | 0.14 | 0.32 | 0.23 |
| Q13. Back Pair After the Mission | 3.0±2.8 | 2.8±2.8 | | | |

4. Question 14 asked the Soldiers to rate pain/discomfort in each body segment during the missions. Table J3 shows a comparison of the NSP and SP groups on these ratings. Soldiers in SP group reported less pain/discomfort on all the measures, but these differences were larger for the head, back, shoulder, and lower body (hip, leg foot) areas.

Table J3. Pain/Discomfort in Different Anatomic Locations During the Missions

| | Before 9 Feb 09 | After 9 Feb 09 | Difference (%) | p-value[a] |
|---|---|---|---|---|
| Q14a. Head/Neck/Eye Pain | 1.6±2.3 | 2.1±2.8 | 31.3 | 0.26 |
| Q14b. Upper/Mid Back Pain | 2.0±2.4 | 2.5±2.8 | 25.0 | 0.26 |
| Q14c. Low Back/Pelvic Pain | 3.0±2.9 | 2.7±2.8 | 10.0 | 0.53 |
| Q14d. Shoulder/Upper Arm Pain | 1.4±2.3 | 1.7±2.7 | 21.4 | 0.78 |
| Q14e. Elbow/Mid Arm Pain | 0.8±1.6 | 1.0±2.2 | 25.0 | 0.90 |
| Q14f. Forearm/Wrist Pain | 0.7±1.5 | 1.0±2.2 | 42.8 | 0.88 |
| Q14g. Hand Pain | 0.6±1.5 | 0.7±2.0 | 16.7 | 0.51 |
| Q14h. Upper Leg/Hip Pain | 1.2±2.0 | 1.1±2.2 | 8.3 | 0.39 |
| Q14i Mid Leg/Knee Pain | 1.2±2.0 | 1.4±2.5 | 16.7 | 0.96 |
| Q14j. Lower Leg/Foot Pain | 1.0±2.0 | 1.0±27.1 | 0.0 | 0.85 |

Notes:
[a]Mann-Whitney U Test

Questions 17, 18, and 19 on the Mission Questionnaire asked Soldiers in the SP group to rate the seat pad on its comfort, its ability to reduce shock and vibration, and how it affected the typical back pain/discomfort the Soldier experienced while driving. Table J4 shows that differences in the before and after periods were small but there was a tendency for Soldiers in the after period to rate the pads as less comfortable and less able to reduce shock and vibration. Nonetheless, there was also a tendency or Soldiers in the after period to indicate the seat pad resulted in less pain/discomfort.

Table J4. Rating of the Seat Pad on Comfort, Ability to Reduce Shock and Vibration, and Effect on Back Pain/Discomfort

| Rating Types | Rating Scales | Before 9 Feb 09 Average±SD Rating | After 9 Feb 09 Average±SD Rating | p-value |
|---|---|---|---|---|
| Rating of the seat pad in terms of comfort | *Very uncomfortable* *neutral* *very comfortable*<br>0 1 2 3 4 5 6 7 8 9 10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | 5.0±2.9 | 4.3±2.4 | 0.14 |
| Rating of the ability of the seat pad to reduce shock and vibration[a] | *poor* *fair* *neutral* *good* *very good*<br>0 1 2 3 4 5 6 7 8 9 10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | 4.9±2.7 | 4.4±2.4 | 0.37 |
| Effect of the seat pad on typical back pain/ discomfort when driving | *less pain/discomfort* *no effect* *more pain/discomfort*<br>0 1 2 3 4 5 6 7 8 9 10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | 4.0±2.7 | 3.6±2.0 | 0.39 |